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CORRIGENDA

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Page 23, line 4: *for* 2ff *read* off.

Page 27, line 5: for *subquarata* read *subquadrata.*

Page 29, line 1: *for* ane *read* and.

Page 37, line 8: *for* Chôsli *read* Chôshi.

Page 64, line 18: for *Pseudorhabdosynochs* read *Pseudorhabdosynochus.*

Page 111, line 15: *for* summerized *read* summarized.

Page 123, line 7 from bottom: *for* Naviclaceae *read* Naviculaceae.

Page 139, line 6 from bottom: *for* **Boceroides** *read* **Boloceroides.**

Page 141, line 12 from bottom: *remove* Oceanic, warm-water form. *to line* 9 (*from bottom*) *and insert after* February.

Page 141, line 19: *for* sp. 1 *read* sp. 2.

Page 143, lines 4~6: *remove* **Peraclis reticulata** (D'ORBIGNY)......*to page* 145 *and insert between* **Limacina trochiformis** *and* **Styliola subula.**

Page 145, line 15 from bottom: *for* **polyhemoides** *read* **polyphemoides.**

Page 160, line 19: *for* **Megacercus** *read* **Megalocercus.**

Page 162, line 5: *for* var. *read* forma.

Page 162, line 7: *for* **democrarica** *read* **democratica.**

Page 163, line 2 from bottom: *for* Hokuryukan, Tokyo *read* Hoikusha, Osaka. 8 color plates, 230 pages.

Page 165, line 5 from bottom: *for* us *read* the authors.

Page 165, line 8 from bottom: for *Echinometera* read *Echinometra.*

Page 166, line 13: *for* genitial *read* genital.

Page 169, line 16: *for* no *read* any.

Page 170, line 1: *insert* are *between* tests *and* 1.2.

FURTHER NOTES ON SOME APPENDICULARIANS FROM THE EASTERN PACIFIC[1][2]

Takasi TOKIOKA

Seto Marine Biological Laboratory, Sirahama

With 10 Text-figures

This is the second taxonomic note on appendicularians collected by and stored in the laboratory of the Scripps Institution of Oceanography. After the manuscript of my paper, "Two new appendicularians from the Eastern Pacific, with notes on the morphology of *Fritillaria aequatorialis* and *Tectillaria fertilis*" (Tokioka, 1957) had been sent to the editor of the Transactions of the American Microscopical Society, the examination of the plankton samples collected by Shellback and Equapac Expeditions was continued for three months. During this time, I found a few more perfectly preserved specimens of *Fritillaria taeniogona* Tokioka and some sexually mature individuals of the form described under the name of *Fritillaria aequatorialis* Lohmann in the paper mentioned above. Critical studies of these specimens made it clear that the former were related to the genus *Tectillaria* more closely than to the genus *Fritillaria.* The latter group differs distinctly from *Fritillaria aequatorialis* Lohmann not only in the form of the tail, but also in the structure of the gonad, thus they belong to a new species, for which the name "*pacifica*" is proposed. In addition, the results of the detailed examination of *Fritillaria aberrans* Lohmann and *Fritillaria magna* Lohmann, both described rather insufficiently to this date, and short notes on *Folia gracilis* Lohmann and *Megalocercus abyssorum* Chun are given here. Among the morphological characteristics of *Fritillaria aberrans* and *Fritillaria magna* Lohmann, it is most interesting that a circular muscle-like band is found in the anterior part of the pharynx, previously no muscular band has ever been observed on the trunk of any of the appendicularians.

Before going further, I wish to express my hearty thanks to members of the staff who granted me the fovour of having a seat at Scripps Institution of Oceanography for a year, and especially to Prof. Martin W. Johnson for his kindness in providing facilities.

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1) Contribution from Scripps Institution of Oceanography, New Series.

2) Contributions from the Seto Marine Biological Laboratory, No. 316.

Publ. Seto Mar. Biol. Lab., VII (1), 1958. (Article 1)

1. *Megalocercus abyssorum* CHUN, 1888

(Fig. 1)

CHUN, C. (1888): Die pelagische Tierwelt in grösseren Meerestiefen und ihre Beziehungen zu der Oberflächenfauna. Bibliotheca Zoologica, I (1), pp. 40–42.

SEELIGER, O. (1893–1911): BRONN's Klassen und Ordnungen des Tier-Reichs, III Supplement Tunicata I abt., pp. 138–139, Taf. I figs. 3–5.

LOHMANN, H. und BÜCKMANN, AD. (1926): Ergebn. Deutsch. Südpolar-Exped., Bd. 18 (Zool. Bd. 10).

LOHMANN, H. (1933–34): KÜKENTHAL u. KRUMBACH-Handbuch d. Zoologie, Bd. V, Zweite Hälfte Tunicata, p. 186, Figs. 64–3 and 149.

BERNARD, M. F. (1954): Bull. Société d'Hist. Nat. Afrique d. Nord, Tom. 45, pp. 344–347, 2 figs.

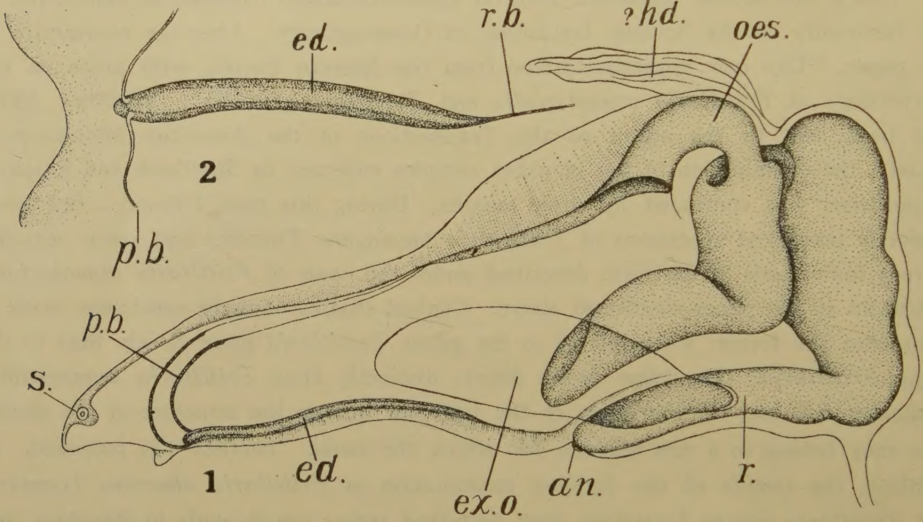

Fig. 1. *Megalocercus abyssorum* CHUN. 1—Left side of the 1.6 mm long trunk from MP–10. 2—Endostyle of the same specimen, dorsal side. *an.*···anus, *ed.*···endostyle, *ex.o.*··· gill opening, *?hd.*···?hood, *oes.*···oesophagus, *p.b.*···peripharyngeal band, *r.*···rectum, *r.b.*···retropharyngeal band, *s.*···statocyst.

Two specimens found in the examined samples, and belonging to the genus *Megalocercus,* differ distinctly from *M. huxleyi* (RITTER) which is distributed very widely and commonly in the Pacific. They each have a strangely shaped left stomach-lobe with a striking elongate blind caecum at the antero-ventral angle, which projects forward along the dorsal side of the rectum (*r.*) as far as its distal end, reaching approximately the level of the anus (*an.*). The endostyle (*ed.*) is elongate and very slender; the gill openings (*ex.o.*) are very large and devoid of ciliated spiracles. The smaller of the two specimens has a hood-like appendage (*?hd.*) attached dorsally near the junction between the small right stomach-lobe and the rather voluminous intestine. It is not clear whether this is a natural structure or a piece of torn epidermis. The existence of a blind caecum at the antero-ventral edge of the left stomach-lobe in these two specimens is so remarkable that they can't be considered as malformed individuals of *M. huxleyi*. It is much more natural to regard them as *M. abyssorum* CHUN. Both specimens are immature. The tail fin is quite wide and devoid of any gland cells. Measurements of these specimens are:

Specimen	Length of trunk	Length of tail	Locality	Haul depth
No. 1	1.6 mm	5.2 mm	Midpac 10 4°41.1′N 140°06.0′W	ca. 80 fathoms
No. 2	3.6 mm	14 mm	Shellback 145 ca. 12°S ca. 85°W	ca. 400 m - 0

M. abyssorum has only been reported from the waters around Italy and the Bay of Algeria. This is the first report of the species from other than the Mediterranean Sea.

2. *Folia gracilis* LOHMANN, 1892

(Fig. 2)

LOHMANN, H. (1892): Vorbericht über die Appendicularien der Plankton-Expedition. Ergebn. Plankton-Exped., Bd. I, A, p. 147, Fig. 33.

Folia aethiopica—LOHMANN, H. (1892): ibid, Fig. 29.

LOHMANN H. (1896): Ergebn. Plankton-Exped., Bd. II, E c, pp. 81–83, Pl. XIX.

Folia gracilis—LOHMANN, H. and BÜCKMANN, AD. (1926): Ergebn. Deutsch. Südpolar-Exped., Bd. 18 (Zool. Bd. 10).

LOHMANN, H. (1931): Deutsch. Tiefsee-Exped., Bd. XXI, Hft. 1.

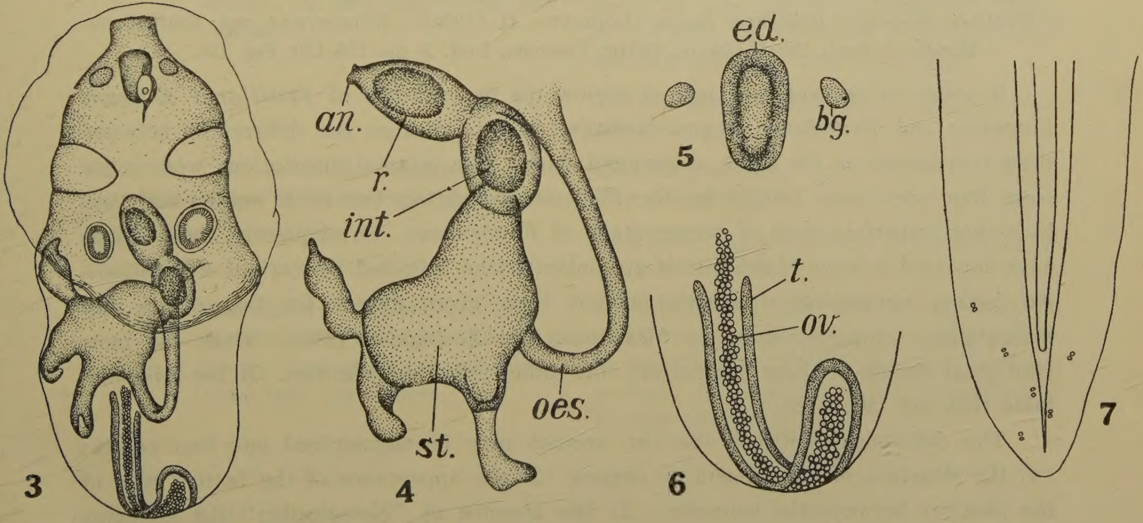

Fig. 2. *Folia gracilis* LOHMANN. 3—Dorsal side of the trunk, ×127. 4—Dorsal side of the alimentary canal, enlarged. 5—Endostyle and buccal glands. 6—Dorsal sight of the gonad, enlarged. 7—Distal half of the tail. *an.*···anus, *bg.*···buccal gland, *ed.*···endostyle, *int.*···intestine, *oes.*···oesophagus, *ov.*···ovary, *r.*···rectum, *st.*···stomach, *t.*···testis.

This species is already known from the Central Pacific, having been found in the plankton samples collected by Friedlich DAHL (1896–97) near the Bismarck-Archipelago (LOHMANN, 1931). I found a single small specimen in the sample taken at the Shellback station 142 (ca. 15°S × ca. 85°W, ca. 400 m—0). The trunk is 477 μ in length and the tail is 1625 μ long. The general structure of the trunk of the present specimen conforms well with that given by LOHMANN (1896), although there are some slight differences between LOHMANN's specimens and mine. The first is the existence of three remarkable glandular protuberances on the stomach of the Shellback specimen. The second is in the shape of the testis, which in the present specimen, is a thin string-like gland, situated on the mid-line of the posterior trunk and arranged as is shown in 6 of Fig. 2. The last is in the existence of several minute gland cells in the poterior part of the tail fin of the Shellback specimen. The posterior end of the chorda is a considerable distance from the posterior end of the musculature. The width of the chorda/the width of the musculature is 0.30–0.31 near the middle of the tail. All these differences are probably due to the condition of preservation or the degree of maturity. They don't appear to be valid as specific or racial characteristics differentiating the Shellback specimen from LOHMANN's specimens.

3. *Fritillaria aberrans* LOHMANN, 1896

(Figs. 3–5)

LOHMANN, H. (1896): Die Appendicularien der Plankton-Expedition. Ergebn. Plankton-Exped., Bd. II, E c, pp. 36–37, Taf. V figs. 5 and 6.

Fritillaria magna—LOHMANN, H. (1896): ibid, pp. 37–39, Taf. V figs. 4, 7–9.

Fritillaria aberrans+*Fritillaria magna*—LOHMANN, H. (1933): KÜKENTHAL and KRUMBACH-Handb. d. Zool., Bd. V, Zweite Hälfte Tunicata, Lief. 2, pp. 138–139, Fig. 126.

It seems to be necessary first to review the descriptions of *Fritillaria aberrans* LOHMANN and *Fritillaria magna* LOHMANN and to discuss the differences between these two species on the basis of previous data. The original discriptions were made from four specimens caught by the Plankton-Expedition, two of *F. magna* and two, in a very imperfect state of preservation, of *F. aberrans*. Subsequently, their names have appeared in some of the lists of appendicularians collected by various expeditions. No further morphological description has been given except for that of the tail musculature, which appeared in "Handbuch der Zoologie" (1933). Thus, the morphological details of these species are only rather imperfectly known. In the following table they are compared.

The differences between the two species may be summarized into four points: (1) the structure of the alimentary organs, (2) the appearance of the bottom wall of the pharynx between the spiracles, (3) the absence of "Nesselzellen"-like elements on the oikoplast-epithelium in *F. aberrans* and (4) the number and arrangement of muscle bands in the tail musculature.

I have found 49 specimens of a form of *Fritillaria*, which is referable to both

	F. aberrans	*F. magna*
Trunk	Exact shape unknown, genital portion is missing in all specimens studied. Hood is present. 1000–1390 μ long excluding the posterior genital portion.	Elongate, at least in the individual with developed testis. Genital portion long; posterior end rounded. Hood well developed and terminating anteriorly in an obtuse end. Up to 5 mm in length.
Pharynx	Endostyle as in *F. magna*. Spiracles very long. A small sac-formed glandular organ present on the outer side of each spiracle? Bottom of pharynx between the spirables is walled with two series of cells with distinct nuclei.	Endostyle is situated nearly in front of the oikoplast-epithelium and curled strongly to the dorsal side; its anterior terminal portion is much broader than the rest. Spiracles very long. A small elongate sac-formed glandular organ is present on the outer side of each spiracle, approximately at the middle of spiracles.
Oesophagus		Short, but thick.
Stomach and Intestine	Large stomach is situated on the left and intestine and rectum on the right side. A number of spherical protruded cells are found on the stomach. A glandular appendage, a squashed bladdery vesicle, on each side of the intestine.	Large stomach occupies the whole dorsal side of the mass of the alimentary organs and is provided with a number of large spherical protruded cells in the younger specimen, but with a number of bundles of finger-shaped protuberances in the older individual. A cell group on each side of the intestine, consists of 3–4 cells, of which one is thickly walled and with somewhat brighter contents.
Gonad		Testis large and elliptical in shape. Ovary unknown.
Oikoplast-epithelium	"Das Fehlen der Nesselzellen ähnlichen Elemente des Integuments."	Consisting of many small follicular cells as in *F. fraudax*.
Small gland cells		Two pairs of gland cells on the dorsal side of the genital portion.
Tail	Musculature consists of 10–14 muscle bands which are each distinctly discernible, but not separated from one another.	Musculature of a medium width and consisting of 5–10 wide muscle bands which are 23–58 μ in breadth and slightly separated from one another. Fin is wide and ends posteriorly in a single pointed terminal.

of the species under discussion. Two were from Equapac samples, 2 form Midpac samples and 45 in the Shellback samples; the Shellback and Equapac samples were taken by oblique hauls generally between 400 m depth and the surface, the Midpac samples were from 400–600 m depth to the surface (MP-3 600–500 m, MP-7 220 fathoms). Many specimens were imperfectly preserved, but some retained portions of the body which were perfectly preserved. The following description of the form is synthesized:

Trunk: Elongate as in *F. haplostoma* FOL. The anterior portion of the trunk, in front of the stomach, is considerably longer than the posterior portion, behind the stomach, in immature individuals (65 : 42 in an individual from MP-3). The two portions are nearly equal in individuals with mature gonads (21 : 19 in a mature individual). Generally the trunk is broadest at attachment of the hood and narrowest just posterior to the stomach, the width/the length of the trunk varies from 0.26 to 0.8 in a 6.2 mm long individual from MP-3. A distinct hood is present; the shape of the upper lip is similar to that of *F. haplostoma*. The tip of the upper lip generally protrudes from the hood and is usually obtusely pointed, although it may be sharply acute as in an individual from MP-3, or rounded as in some specimens from the Shellback and Equapac samples. Sometimes the hood may be long enough to cover the whole upper lip. The posterior margin of the trunk is generally truncated, or rarely, narrowed and forming a pointed end. It is not certain whether such appearance is natural. The oiloplast-epithelium seems to cover the dorsal side of the distal half of the anterior portion of the trunk. A pair of very elongate spiracles are situated wholly beneath this epithelium. The endostyle is short and strongly curved upwards. A pair of large roundish gland cells are found behind the endostyle approximately at the level of the anterior end of the spiracles. A pair of minute gland cells are situated slightly posterior to the above-mentioned pair. A gland cell of medium size is located on the outer side and at about the middle of each spiracle.

The most remarkable characteristic is the existence of a muscle-like structure encircling the pharynx at about the center of the posterior half of the endostyle. The structure is rather delicate, but distinctly discernible by staining the specimens with Rose Bengal. Frequently it is found broken. At first, I thought it might be the peripharyngeal band, but its location clearly differs from that of the peripharyngeal band and moreover it faintly shows a structure which may be expressed as fibrous. I am inclined to consider this structure as a primitive circular muscle. So far as I am aware, there is no certain record of the existence of any muscle on the trunk of appendicularians, except for a fibrous structure found at the heart. In the late 19th century it was supposed that the epithelium of *Megalocercus abyssorum* was a kind of musculature (CHUN, 1888), but this was nothing but the misidentification of the imperfectly preserved oikoplast-epithelium as musculature. This may thus be the first time the existence of body musculature has been found in appendicularians with any considerable certainty. It is very desirable that more perfectly preserved specimens

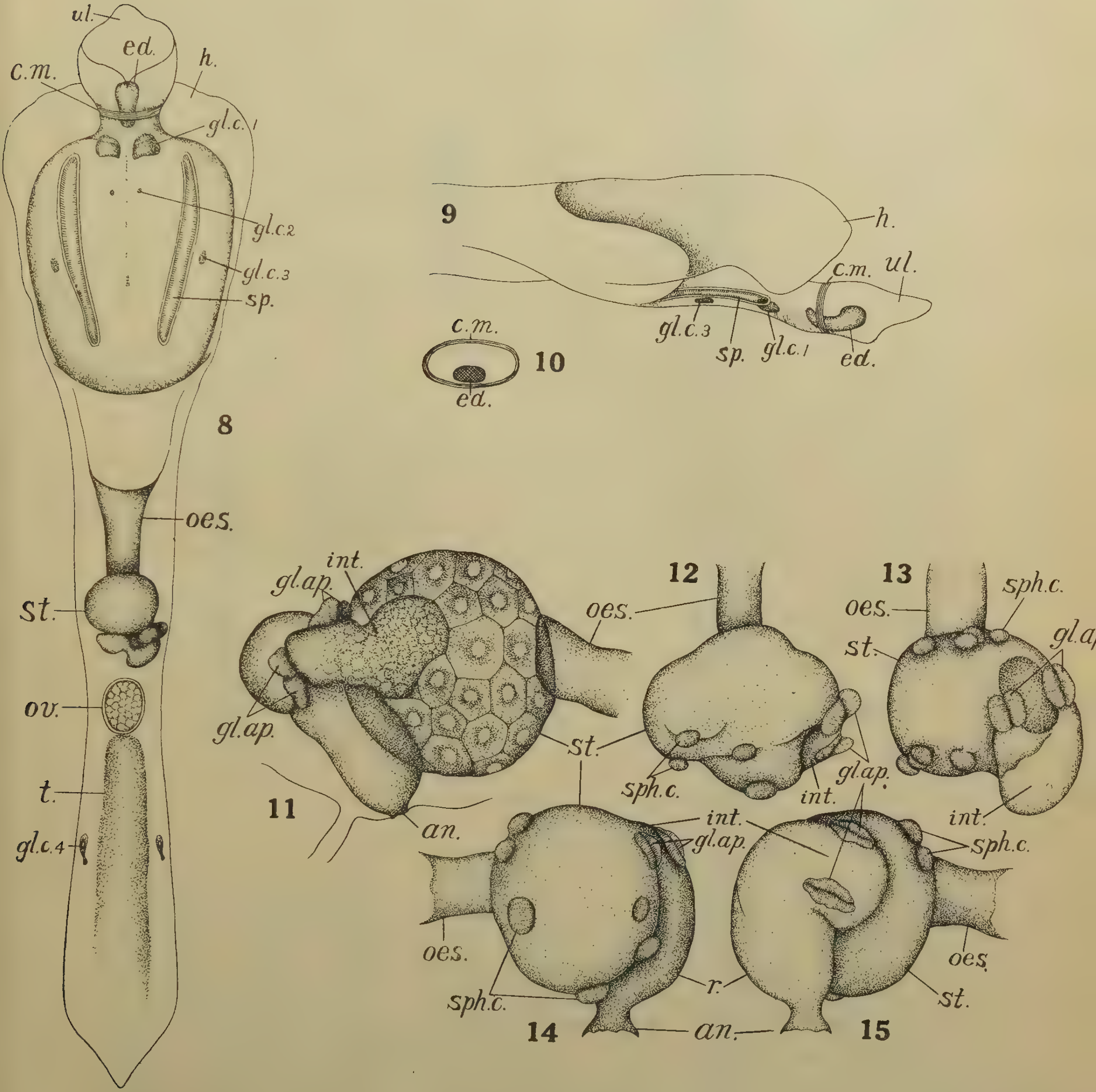

Fig. 3. *Fritillaria aberrans* Lohmann. 8—Ventral side of the trunk. 9—Pharyngeal portion, right side. 10—Schematic representation of the section through the circular muscle. 11—Alimentary organ of an individual from MP-3, right side. 12 -Alimentary organ of other specimen, dorsal side. 13—ditto, dorsal side. 14 ditto, left side. 15—Right side of the same alimentary organ. *an.*···anus, *c.m.*···circular muscle, *ed.*···endostyle, *gl.ap.*···glandular appendage, *gl.c.* 1-4···small gland cells, *h.*···hood, *int.*···intestine, *oes.*···oesophagus, *ov.*···ovary, *r.*···rectum, *sp.*···spiracle, *sph.c.*···spherical cells projecting out from the stomach wall, *st.*···stomach, *t.*···testis, *ul.*···upper lip.

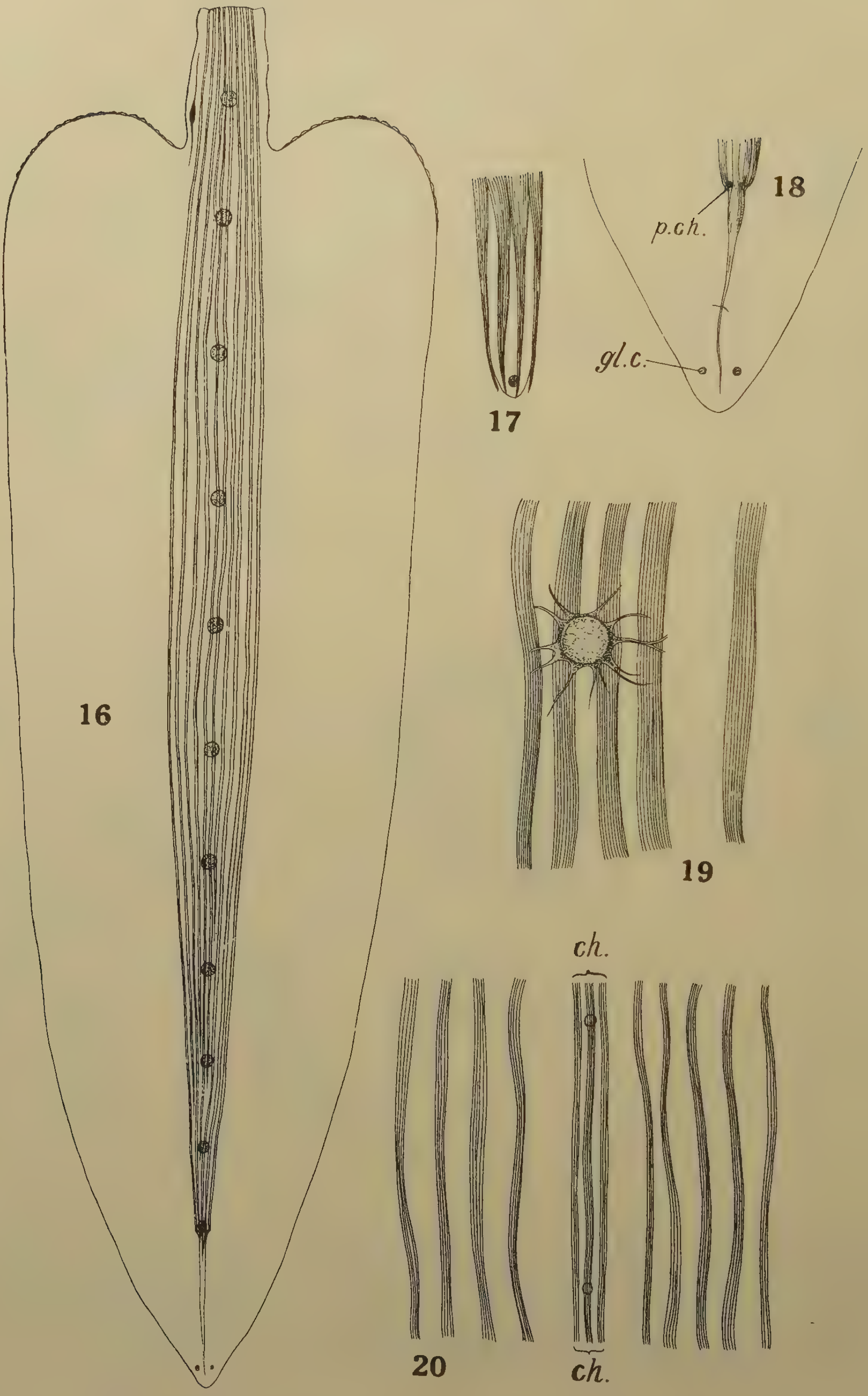

Fig. 4. *Fritillaria aberrans* LOHMANN. **16**—Tail of an individual from MP-3, ×ca. 15. **17**—Posterior end of the tail musculature, magnified. **18**—Extension of a fine muscle band beyond the posterior end of the tail musculature, magnified. **19**—A part of the tail musculature, showing a chordal nucleus, ×127. **20**—Ditto, less magnified. *ch.*···chorda, *gl.c.*···gland cell, *p.ch.*···posterior end of chorda.

be carefully examined to confirm this structure, for the existence of circular musculature in the appendicularians may allude to the possibility of the existence of a certain direct relationship between this animal group and Thaliacea.

The oesophagus is thick, the stomach is spherical in shape with the intestine and rectum situated on its right posterior side. The relative positions of these organs is considerably variable, depending on the state of the preservation. Usually there are several (2–3 to 6–7) protruded spherical cells over the stomach surface. In some rare cases, however, none of these cells are found on the stomach, and its surface is nearly smooth. The stomach, in an individual from MP–3, was 520 μ in diameter. Generally a pair of glandular appendages are found on the intestine as in *F. haplostoma.* They are usually squashed, or flattened so strongly that in some specimens they can hardly be detected. In many cases, the appendages are deeply depressed along their axes parallel to the intestine, leaving both sides highly elevated, so that they look as if they each consist of two lamine. In two of the specimens examined, each glandular appendage appears to consist of two cells. It is not clear, however, whether they really consist of two cells or a single cell which is strongly folded into two swollen laminae. More critical examination of perfectly preserved specimens is necessary before a definite description of the structure of the glandular appendage can be given.

Gonads were found in a single individual from MP–3. The ovary was an oval mass located just behind the stomach and the testis seems to form an elongate mass as in *F. haplostoma.* An elongate gland cell is present on each side of the testis near its middle (*gl. c.* 4).

Measurements of representative specimens are:

Source	Length of trunk	Length of tail	C/M×100
SB-112	3.3 mm	8.5 mm	43.3
SB-112	2.6 mm (anterior portion)	8.1 mm	
SB-180	4.9 mm	8.5 mm	
MP-3	6.2 mm	12.5 mm	

Tail: The largest tail was 13 mm in length. The musculature is of moderate width and consists of 10–12 (most frequently 10) muscle bands on one surface, in the present material. Generally speaking, the muscle bands touch one another in younger specimens, while they are separated from one another in fully grown individuals. Near the posterior end the musculature consists of 4 muscle bands on one surface and terminates just at the posterior end of the chorda. In some specimens, however, these four muscle bands extended posteriorly beyond the distal end of the chorda, and unite into two thin bands which then fuse into a single fine band. The width of the chorda/the width of the musculature is rather large (2/3 in an individual from MP–3) in younger specimens, but it decreases remarkably in fully grown individuals, in which the muscle bands are widely separated. The ratio is only 1/7–1/9 in an individual from SB–115. The chorda is covered on each surface by 3–4 muscle bands and provided with 11 roundish chordal nuclei in a specimen from MP–3. The fin is rather wide, ending posteriorly in a single acute tip as in *F. haplostoma.* The margin along the shoulder-like antero-lateral angles is ciliated. Only a small pair of gland cells, near the posterior end, is observed on the surface of the fin. The 12.5 mm long tail, of an individual from MP–3, is broadest at the level of the shoulder-like antero-lateral angles (width/length = 0.32). The musculature is widest (780 μ) slightly anterior to the middle of the fin.

The above-mentioned form appears to resemble both *F. aberrans* and *F. magna.* It most likely combines these two species into a single one. The first of the four differences between *aberrans* and *magna*, the differences found in the structure of the alimentary organs, is rather variable in the present form. LOHMANN's *magna* has 3–4 cells instead of the single glandular appendage of intestine as in *aberrans.* It is, however, very possible that one of these 3–4 cells, which is thickly walled and with somewhat clear contents, may represent the glandular appendage and other 2–3 cells belong to the spherical protruded cells which are found scattered over the stomach surface. The fact that LOHMANN's original specimens of these two species, especially of *aberrans*, were in a very unsatisfactory condition, seems to decrease considerably the validity of the above-mentioned distinction. The second and the third of the differences are evidently due to the state of preservation. The last of the four differences, the number and arrangement of muscle bands of tail musculature, are quite continuous between *aberrans* and *magna.* It appears that they vary with age,

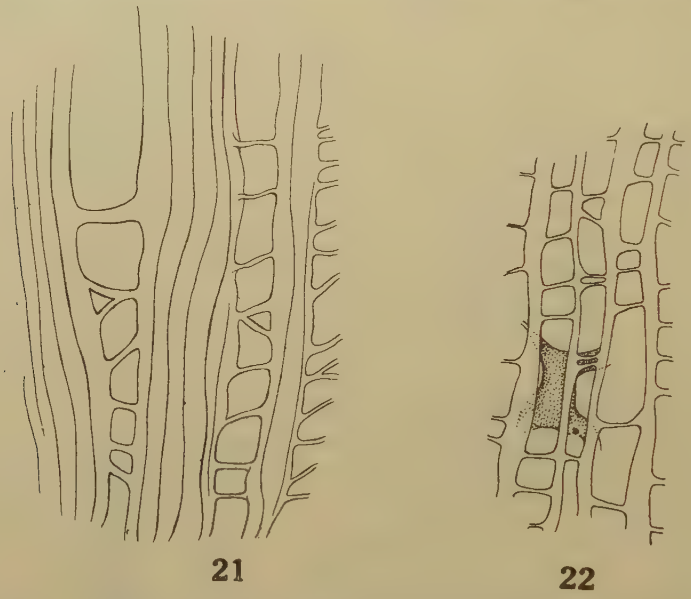

Fig. 5. *Fritillaria fraudax* LOHMANN. **21–22**—Parts of the tail musculature of an old, fully grown individual, magnified.

condition of preservation and even individually. The liberation of respective muscle bands is not confined to this "Formenkreis", but also it can be seen in other species. A part of the tail musculature of an old fully grown individual of *F. fraudax* LOHMANN, from SB–60, is shown as an example (Fig. 5).

Throughout above-mentioned discussions, I am inclined to believe that *F. aberrans* and *F. magna* are identical, and the name *F. aberrans* should be reserved according to the law of the page priority.

4. *Fritillaria pacifica* n. sp.

(Figs. 6–9)

Fritillaria aequatorialis—TOKIOKA, T. (1957): Two new appendicularians from the Eastern Pacific, with notes on the morphology of *Fritillaria aequatorialis* and *Tectillaria fertilis*. Trans. American Microscop. Soc., Vol. LXXVI, No. 4, pp. 364–365, Figs. 3C, 4 D–E.

Forty-one specimens in all have been examined, 26 from Equapac material and 15 from Shellback material. When I described the morphology of the tail of this form (TOKIOKA, 1957), I had no specimens with any trace of gonads. The identificacation was made on the most perfectly preserved specimen from SB–10, which is shown here in Fig. 6. The trunk was 1510 μ in length and somewhat elongate in outline. The genital portion (empty in this specimen), posterior to the alimentary organ, was about half as long as the anterior portion in front of the stomach, which was much more spacious than the genital part. The mouth closely resembles that of *Fritillaria fraudax* LOHMANN (Fig. 9) and is wholly covered by the hood. The oikoplast-epithelium consists of two pairs of elongate elliptical cell groups and is bordered by six large cells along the posterior margin. The endostyle is very markedly curved. The spiracles are rather large and elliptical in outline. The ciliated dorsal lamina can be traced to near the mid point between the posterior end of the endostyle and the oesophageal opening where it becomes quite obscure.

The oesophagus is very long and the stomach is comparatively small, oval in outline and rather smooth walled. The intestine and rectum are situated at the right posterior side of the stomach. There are a pair of distinct roundish glandular appendages on the intestine as found in many species belonging to the subgenus *Eurycercus*. Two additional thin wing-shaped horizontally placed glandular appendages are located at the posterior end of the intestine. In some specimens, a few small spherical cells project from the general contour of the intestine. The wing-shaped glandular appendages consist of a ventral appendage located on the median line of the trunk and a dorsal one slightly displaced to the left. In some mature specimens, the appendages are found detached from the surface of the alimentary organ. The heart is very prominent and somewhat displaced to the left side of the ventro-median line.

The above-mentioned features of the trunk, especially the relative smallness of

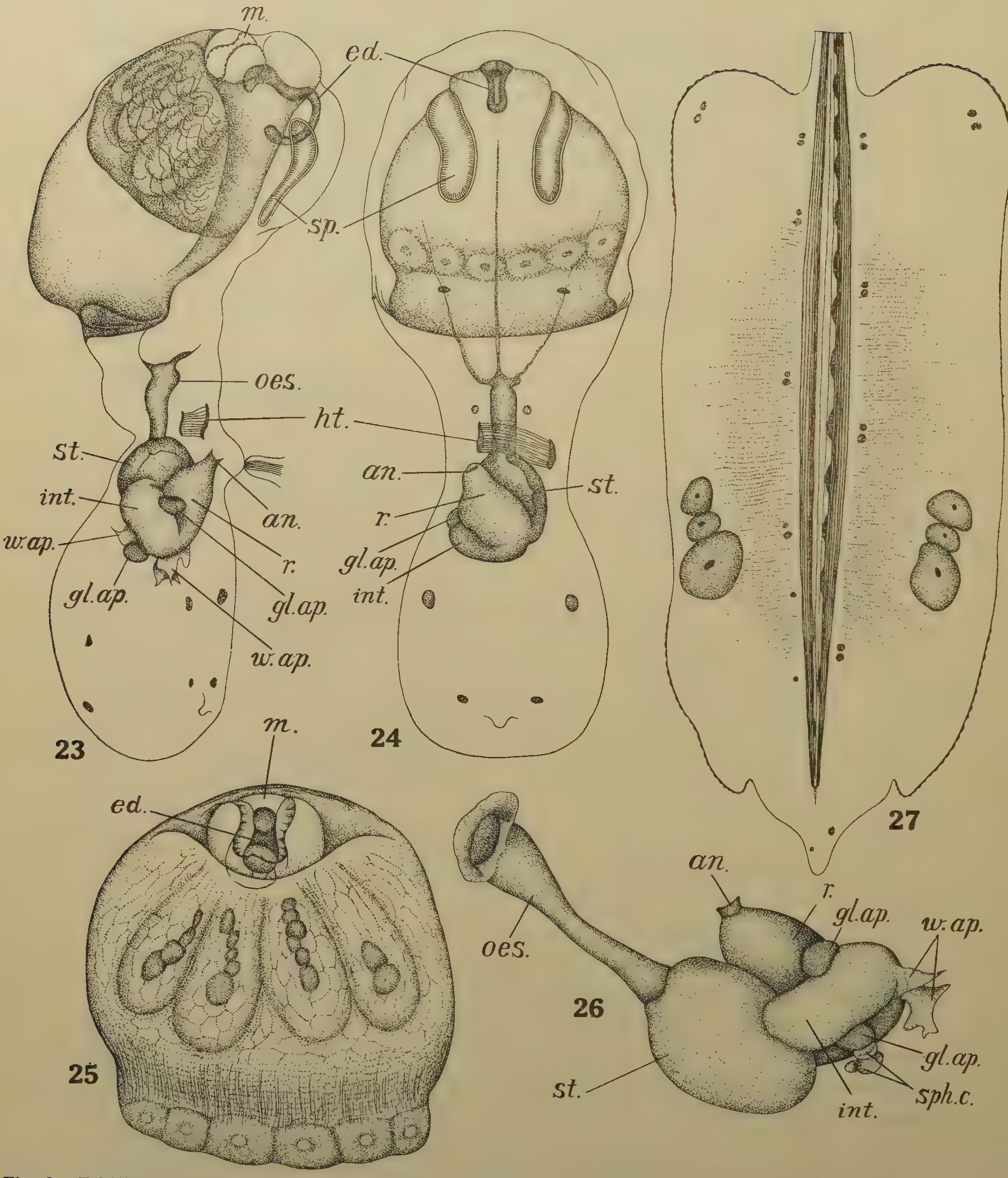

Fig. 6. *Fritillaria pacifica* n. sp. 23—Right side of the trunk. 24—Ventral side of the trunk. 25—Oikoplast-epithelium, dorsal side. 26—Alimentary organ, dorsal. 27—Tail. *an.*···anus, *ed.*···endostyle, *gl.ap.*···glandular appendage, *ht.*···heart, *int.*···intestine, *m.*···mouth, *oes.*···oesophagus, *r.*···rectum, *sp.*···spiracle, *sph.c.*···spherical cell projecting out from the stomach surface, *st.*···stomach, *w.ap.*···wing-shaped membranous glandular appendage.

the genital portion, compared with the spacious pharyngeal part and the general appearance of the alimentary organ, resemble so closely those of *Fritillaria aequatorialis* LOHMANN, described and figured in 1896, that I dared to identify my specimen as *F. aequatorialis.* This was in spite of the distinct difference in the structure of the tail for I thought LOHMANN's description of the tail of *F. aequatorialis* might have been made on some imperfectly preserved specimens. Later, however, I found a single specimen with fully mature gonad in the sample from SB-55 (Fig. 7). The gonad of this specimen consisted of the string-formed ovary and a somewhat membraneous testis, whose lateral sides were curled upwards. This structure of the testis apparently differs from that of *F. aequatorialis* which has "ein eiförmiger, voluminöser Hoden, mit seiner Längsachse schräg von vorn unten nach hinten und oben gerichtet".

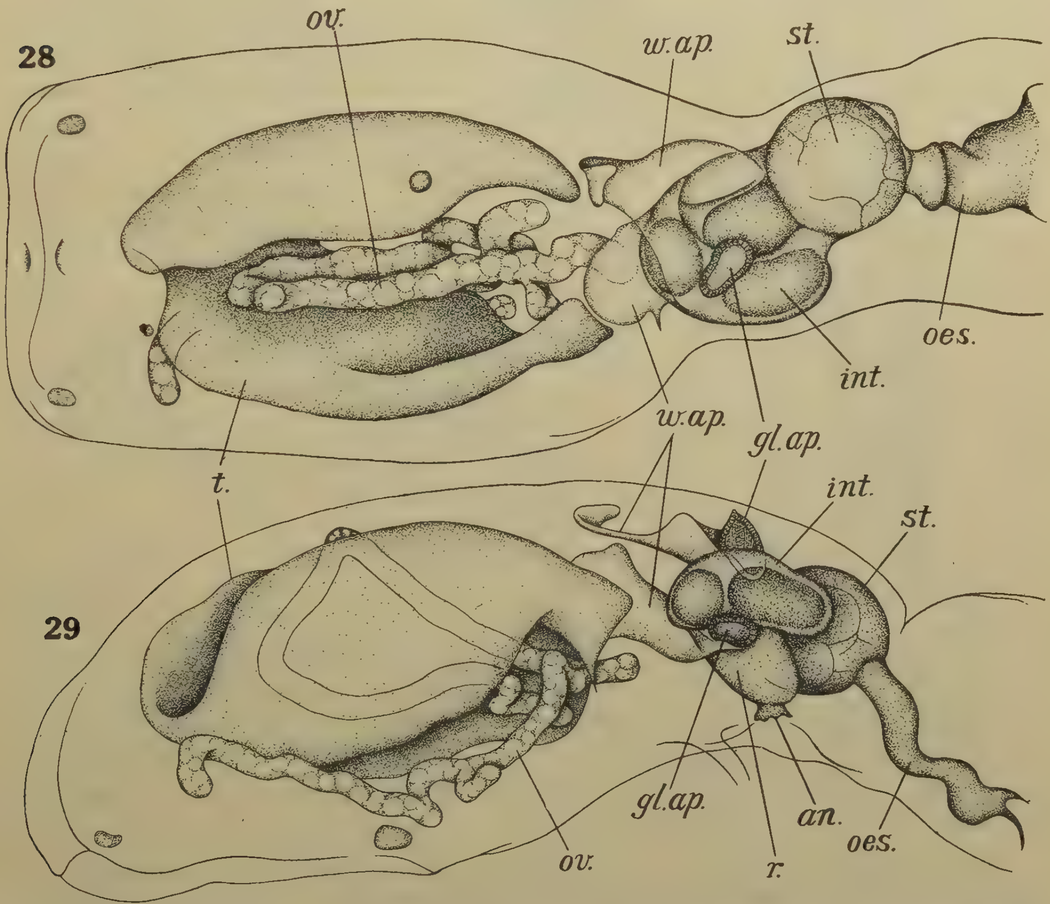

Fig. 7. *Fritillaria pacifica* n. sp., an individual with fully matured gonad, SB-55. 28 -Dorsal side of the posterior half of the trunk. 29—Right side of the same portion. *an.*…anus, *gl.ap.*…glandular appendage, *int.*…intestine, *oes.*…oesophagus, *ov.*…ovary, *r.*…rectum, *st.*…stomach, *t.*…testis, *w.sp.*…wing-shaped membranous glandular appendage.

The ovary of *F. aequatorialis* is also string-shaped as indicated in the original description—"Ihn (the testis) umgeben rechts und links in der Form eines Gürtels je 1 wurmförmigen Ovarialstrang, der bei älteren Thieren Rosenkranz-ähnliche Einschnürungen in Eifächer zeigt". The ovary and the testis were arranged so complicatedly or rather irregularly in the specimen from SB-55, I could find no definite difference between the gonads of respective forms until specimens with gonads in various stages of development were found in samples of the Equapac Expedition. By examining these specimens in detail, it is definitely established that the structure of the gonad of the present questionable form differs distinctly from that of *F. aequatorialis*. The structure of the gonad is shown in Fig. 8.

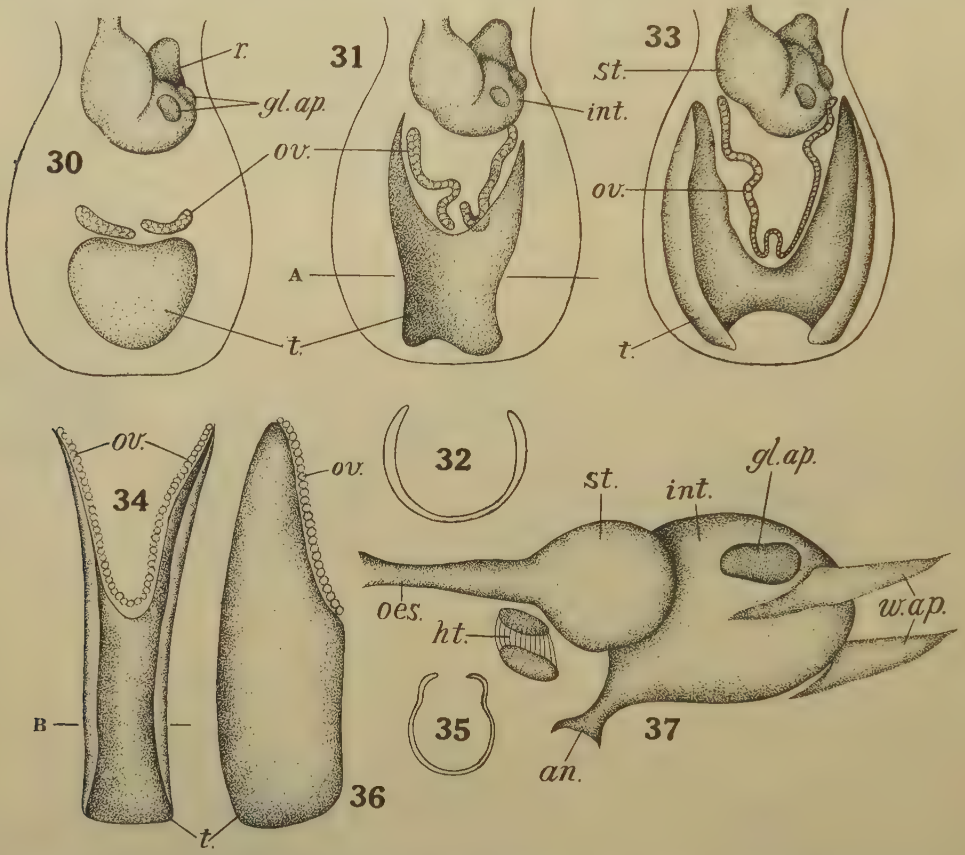

Fig. 8. *Fritillaria pacifica* n. sp., gonads and alimentary organ shown somewhat schematically. 30, 31, 33—Three stages of the successive development of the gonad. 32—Transverse section through the line A of the testis shown in 31. 34—Gonad of an individual from SB-137, dorsal. 35—Transverse section through the line B of the testis shown in 34. 36—Left side of the same testis. 37—Left side of the alimentary organ, shown somewhat schematically. *an.*···anus, *gl.ap.*···glandular appendage, *ht.*···heart, *int.*···intestine, *oes.*···oesophagus, *ov.*···ovary, *r.*···rectum, *st.*···stomach, *t.*···testis, *w.ap.*···wing-shaped membranous glandular appendage.

In earlier stages, the testis forms a semicircular disc placed horizontally with a convex posterior margin and a truncate anterior edge. The ovaries are represented by two sausage-shaped pieces situated along the anterior margin of the testis. The lateral sides of the testis extend gradually towards the anterior and dorsal side, thus finally it grows up to a laminary mass curled up to the dorsal side along the lateral margins. Its anterior margin is remarkably concave. The ovaries of both sides become longer along the concave anterior margin of the testis and are usually found united in fully mature gonads.

It is clear that the specimens treated here represent a new species distinctly differentiated from any known species of *Fritillaria.* The specific name "*pacifica*" is proposed here for this new species, whose most striking characteristics are the unique shape of the tail and the structure of the gonad.

Finally a short note is given on the distribution of small gland cells throughout the trunk (Fig. 9). There is a small cell on each side of the mouth; two pairs of cells are found in the pharyngeal portion, one near the level of the anterior end of the spiracles and the other at the level near the posterior end of the oiloplast-epithelium. There is a small cell on each side of the oesophagus near its anterior margin, and a single cell near the right dorsal side of the cardiac end of the stomach. Three pairs of cells are found in the genital portion, two on the dorsal side and one along the posterior margin of the trunk. Some of these small gland cells often may be missing.

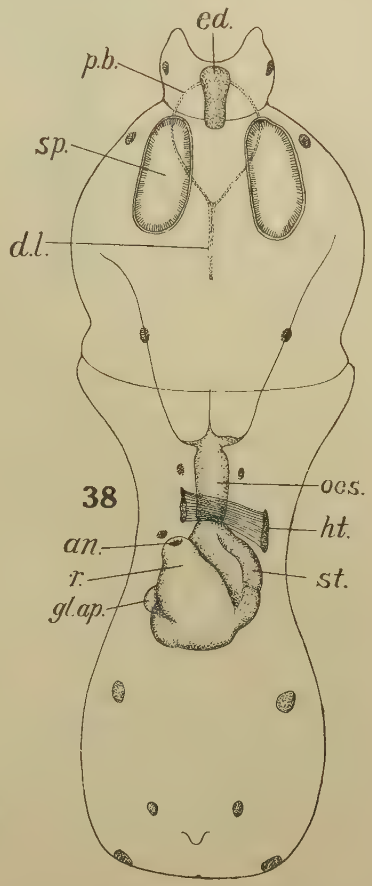

Fig. 9 (38). *Fritillaria pacifica* n. sp. Distribution of small gland cells on the trunk, ventral. *an.*···anus, *d.l.*···dorsal lamina, *ed.*···endostyle, *gl.ap.*···glandular appendage, *ht.*···heart, *oes.*···oesophagus, *p.b.*···peripharyngeal band, *r.*···rectum, *sp.*···spiracle, *st.*···stomach.

Measurements:

Source	Length of trunk	Width of trunk	Length of tail	Width of tail
EQP-H 17	1192 μ		1950 μ	870 μ
EQP-H 17	1340 μ		2170 μ	910 μ
EQP-H 17	1340 μ		2170 μ	975 μ
SB 10	1510 μ	540 μ	2275 μ	870 μ
SB 55	1730 μ			

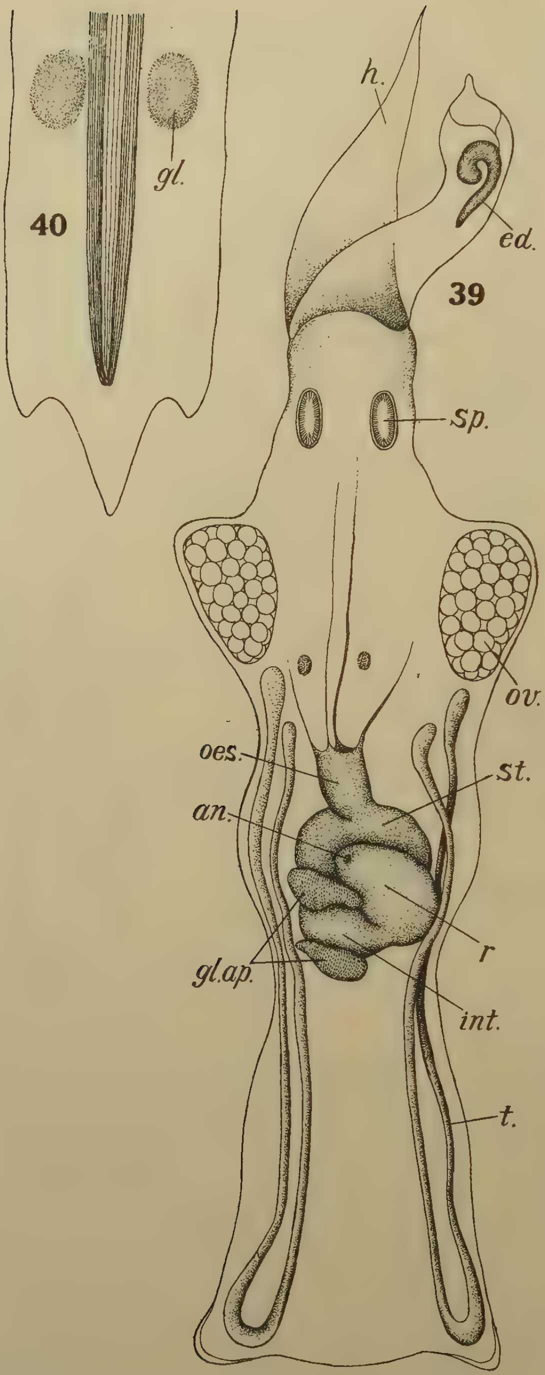

Fig. 10. *Tectillaria taeniogona* (TOKIOKA). **39**—Ventral side of the trunk. **40**—Distal half of the tail. *an.*···anus, *ed.*···endostyle, *gl.*···glandular tissue, *gl.ap.*···glandular appendage, *h.*···hood, *int.*···intestine, *oes.*···oesophagus, *ov.*—ovary, *r.*···rectum, *sp.*···spiracle, *st.*···stomach, *t.*···testis.

Mature specimens of *F. aequatorialis* from the Plankton Expendition are 600–700 μ in trunk length, much smaller than *F. pacifica.*

5. *Tectillaria taeniogona* (TOKIOKA), 1957

(Fig. 10)

Fritillaria taeniogona TOKIOKA, T. (1957): Two new appendicularians from the Eastern Pacific, with notes on the morphology of *Fritillaria aequatorialis* and *Tectillaria fertilis.* Trans. American Microscop. Soc., Vol. LXXVI, No. 4, pp. 363–364, Figs. 3A and B.

A comparatively well preserved specimen was found in the plankton sample from SB–187. The shape of the mouth part resembles somewhat that of *F. haplostoma,* the upper lip being obtusely pointed at the anterior end. Spiracles are comparatively small and elliptical in outline. A pair of small gland cells are present on the pharyngeal wall at the level slightly in front of the anterior end of the oesophagus. The intestine and rectum are situated on the right or right posterior side of the stomach. A very distinct pair of glandular appendages are found on the intestine. They are stained purplish red by Rose Bengal, while the intestinal wall is stained red orange by the same dye. A pair of ovaries are found near the middle of the area between the spiracles and the oesophagus.

The posterior end of the tail fin is pointed and there is a pair of subterminal notches near the distal end, somewhat posterior to the termination of the tail musculature. A vague glandular tissue, roughly round in outline, is faintly observed on each side of the tail musculature, approximately a quarter of the way from the distal end of the tail. Although the exact structure of the oiloplast-epithelium is not yet known for the present species, the above-mentioned structures of both trunk and tail make it reasonable that the present specimen should belong to the genus *Tectillaria* rather than to *Fritillaria.* The genus *Tectillaria* thus acquires here its second member.

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REPORT ON THE MOLLUSCA CHIEFLY CLLLECTED BY THE S. S. SÔYÔ-MARU OF THE IMPERIAL FISHERIES EXPERIMENTAL STATION ON THE CONTINENTAL SHELF BORDERING JAPAN DURING THE YEARS 1922-1930

PART 4. LAMELLIBRANCHIA (2)[1][2]

Tadashige HABE
Amakusa Marine Biological Laboratory (Kyushu University)

With Plates I–II

This is a second report of the Lamellibranchiate molluscs collected from the continental shelf bordering Japan mainly by the S. S. Sôyô-maru, in which 122 species of the Teleodesmid molluscs are listed, including two new genera and sixteen new species as follow:

Venericardia (*Megacardita*) *soyoae* sp. nov.
Lucinoma adamsiana sp. nov.
Soyokellia compressa gen. et sp. nov.
Pitar (*Agriopoma*) *noguchii* sp. nov.
Abra soyoae sp. nov.
Abrina kinoshitai Kuroda et Habe sp. nov.
Moerella nishimurai Kuroda et Habe sp. nov.
Bathytellina citrocarnea Kuroda et Habe gen. et sp. nov.
Lucinoma yoshidai sp. nov.
Lucinoma japonica sp. nov.
Chama argentata Kuroda et Habe sp. nov.
Gari hosoyai sp. nov.
Abra fujitai sp. nov.
Fabulina soyoae sp. nov.
Fabulina abyssicola sp. nov.
Mactra iridescens Kuroda et Habe sp. nov.

My hearty thanks are due to Dr. Tokubei Kuroda for his kind direction in the course of this study.

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[1] Contributions from the Seto Marine Biological Laboratory, No. 317.
[2] Contributions from the Amakusa Marine Biological Laboratory (Kyushu University), No. 120.

Publl. Seto Mar. Biol. Lab., VII (1), 1958. (Article 2)

Subclass TELEODESMACEA
Order HETERODONTA
Superfamily Astartacea
Family Astartidae

131. *Astarte hakodatensis* YOKOYAMA

(Pl. I, figs. 17, 18)

1920 *Astarte hakodatensis* YOKOYAMA, Jour. Coll. Sci. Imp. Univ. Tokyo, **39** (6), p. 140, pl. 11, figs. 5, 6.

Localities: St. 452 (off Gotô Islands, 154 m); St. 475 (off Tsushima, 192 m); St. 491 (off Shimane Pref., 112 m) and St. 652 (Tsugaru Strait, 110 m).

Distribution: Japan Sea and off Gotô Islands.

132. *Astarte* (*Tridonta*) *borealis* (SCHUMACHER)

1817 *Tridonta borealis* SCHUMACHER, Essai Nouv. Syst. Vers. Test., p. 146, pl. 17, fig. 1.
1849 *Astarte corrugata* MIDDENDORFF, Mem. Acad. Sci. Imp. St. Petersburg, (6) **6**, p. 562, pl. 17, figs. 4–10.

Localities: Sts. 47 and 152 (off Iwate Pref., 355 m and 377 m); St. 73 (off Shimokita Peninsula, 390 m); St 481 (off Tsushima, 143 m); Sts. 495 and 498 (off Shimane Pref., 146 m and 139 m) and St. 541 (off Yosa Peninsula, 150 m).

Distribution: Northern Pacific; Hokkaido and Honshu (south to off Tsushima on the Japan Sea coast and off Bôsô Peninsula on the Pacific coast.).

133. *Astarte* (*Tridonta*) *bennettii* DALL

1903 *Astarte bennettii* DALL, Proc. U. S. Nat. Mus., **26**, p. 946, pl. 63, fig. 6.
1935 *Astarte aomoriensis* NOMURA et HATAI, Satio Hô-on Kai Mus. Res. Bull. **6**, p. 115, pl. 9, fig. 5.

Localities: St. 65 (off Iwate Pref., 216 m); St. 78 (off Shimokita Peninsula, 143 m); Sts. 439 and 461 (off Gotô Islands, 155 m and 187 m); St. 475 (off Tsushima, 192 m); St. 475 and 479 (off Urusan, Korea, 148 m and 143 m) and Sts. 491 and 495 (off Shimane Pref., 112 m and 146 m).

Distribution: Bering Sea; Hokkaido; northern Honshu and Japan Sea (south to Gotô Islands).

134. *Astarte* (*Tridonta*) *alaskensis* DALL

1903 *Astarte alaskensis* DALL, Proc. U. S. Nat. Mus., **26**, p. 944, pl. 63, fig. 2.

Localities: St. 71 (off Shimokita Peninsula, 444 m) and St. 511 (off Oki Islands, 267 m).

Distribution: Bering Sea to northern Honshu and Japan Sea.

135. *Astarte* (*Tridonta*) *multicostata* FILATOVA

(Pl. II, fig. 19)

1957 *Astarte multicostata* FILATOVA, Bull. Inst. Oceanology, **23**, p. 297, fig. 1.

Locality: St. 541 (off Yosa Peninsula, Kyoto Pref., 150 m).

Distribution: Bering Sea; Kuriles; Hokkaido and Japan Sea.

Remarks: This species was erroneously reported as *Astarte* (*Tridonta*) *vernicosa* DALL by the writer in 1952.

Family Crassatellitidae

136. *Crassatellites nanus* (A. ADAMS et REEVE)

(Pl. I, fig. 28)

1850 *Crassatella nana* A. ADAMS et REEVE, Voy. Samarang, Moll., p. 81, pl. 23, fig. 2.
1882 *Crassatella japonica* DUNKER, Index Moll. Mar. Jap., p. 220.

Localities: St. 251 (Sagami Bay, 165 m); St. 429 (off Amakusa, 223 m); St. 447 (off Gotô Islands, 90 m); Sts. 468 and 475 (off Tsushima, 112 m and 192 m); St. 481 off Urusan, Korea, 143 m); Sts. 492 and 494 (off Shimane Pref., 132 m and 110 m) and St. 521 (off Oki Islands, 86 m).

Distribution: China; Kyushu; Shikoku; Honshu and Korea.

137. *Crassatellites heteroglyptus* PILSBRY

1889 *Crassatella japonica* SOWERBY, Jour. Linn. Soc. London. Zool., **20**, p. 399, pl. 25, ag. 19 (*non* DUNKER 1882).
1895 *Crassatellites heteroglypta* PILSBRY, Cat. Mar. Moll. Japan, p. 135.

Locality: St. 4 (off Bôsô Peninsula, 287 m).

Distribution: Kyushu; Shikoku and Honshu.

138. *Crassatellites adamsi* (KOBELT)

1850 *Crassatella compressa* A. ADAMS et REEVE, Voy. Samarang, Moll., p. 82, pl. 23, fig. 10, (*non* LAMARCK 1808).
1886 *Crassatella adamsi* KOBELT, Conchyl. Cab., **10** (la), p. 26, pl. 7, fig. 13.

Localities: St. 481 (off Tsushima, 143 m) and Sts. 497 and 498 (off Shimane Pref., 143 m and 139 m).

Distribution: Japan Sea.

139. *Crassatina oblongata* (YOKOYAMA)

(Pl. I, figs. 1, 2)

1920 *Crassatella oblongata* YOKOYAMA, Jour. Coll. Sci. Imp. Univ. Tokyo, **39** (6), p. 143, pl. 11, figs. 8, 9.

Localities: St. 205 (Kumano-nada, 224 m); St. 220 (Tosa Bay, 234 m); Sts. 249 and 255 (Sagami Bay, 229 m and 263 m); St. 257 (off Izu Peninsula, 137 m); Sts. 259, 276, 279 and 286 (Suruga Bay, 188 m, 77 m, 155 m and 123 m); St. 295 (off Tanegashima, 154 m); Sts. 325 and 327 (Bungo Channel, 210 m and 216 m); St. 331 (off Ashizuri-zaki, 344 m); St. 345 (off Muroto-zaki, 165–199 m); St. 349 (Kii Channel, 152 m); St. 352 (off Tanabe, Wakayama Pref., 154 m); St. 379 (Enshu-nada, 391 m); St. 432 (off Gotô Islands, 148 m) and St. 498 (off Shimane Pref., 139 m)

Distribution: Kyushu; Shikoku and Honshu (north to Bôsô Peninsula and Shimane Peninsula).

Superfamily Carditacea

Family Carditidae

140. *Cardita leana* DUNKER

1860 *Cardita leana* DUNKER, Mal. Blatt., **6**, p. 233.
1860 *Cardita cumingiana* DUNKER, Mal. Blatt., **6**, p. 223.

Locality: St. 4 (off Bôsô Peninsula, 287 m).

Distribution: Formosa to Honshu and Korea.

141. *Cardita nodulosa* LAMARCK

(Pl. I, fig. 9)

1819 *Cardita nodulosa* LAMARCK, Anim. s. Vert. **6** (1), p. 25.
1843 *Cardita rufescens* REEVE, Conch. Icon., sp. 19.

Localities: St. 78 (off Shiriya-zaki, Shimokita Peninsula, 143 m); St. 211 (Enshû-nada, 190 m); St. 240 (Sagami Bay, 192 m); St. 296 (off Tanegashima, 219 m); Sts. 319 and 321 (off Miyazaki Pref., 210 m and 457 m); St. 330 (off Ashizuri-zaki, Kochi Pref., 102 m); St. 345 (off Muroto-zaki, Kochi Pref., 165–199 m): Sts. 459, 466 and 468 (off Tsushima, 115 m, 110 m and 112 m); Sts. 491 and 498 (off Shimane Pref., 112 m and 139 m); Sts. 503, 504, 506 and 512 (off Oki Islands, 146 m, 106 m, 176 m and 141 m) St. 554 (off Ishikawa Pref., 95 m); St. 575 (off Noto Peninsula, 123 m); St. 591 (off Niigata Pref., 311 m); St. 620 (off Akita Pref., 139 m); and St. 646 (off Tsugaru Peninsula, 123 m).

Distribution: Kyushu; Shikoku and Honshu.

142. *Glans hirasei* (Dall)

(Pl. I, fig. 15, 16)

1918 *Venericardia hirasei* Dall, Proc. U. S. Nat. Mus., **54**, p. 234.

Localities: St. 220 (Tosa Bay, 234 m); St. 431 (2ff Amakusa, 152 m); Sts. 441 and 442 (off Gotô Islands, 353 m and 340 m) and Sts. 466 and 469 (off Tsushima, 110 m and 91 m).

Distribution: Kyushu; Shikoku and Honshu (north to Sagami Bay).

143. *Venericardita* (*Megacardita*) *soyoae* sp. nov.

Shell rather subquadrate in shape, moderately inflated, anterodorsal margin which is abruptly sloping is shorter than the straight postero-dorsal and rounded anteriorly and truncated posteriorly; ventral margin nearly straight and subparallel with the postero-dorsal margin; beak small, but prominent anteriorly, situated at the anterior third; surface ornamented with about 16–18 radiating ribs which are granulated by the intersection of coarse growth lines, but more or less scaly on the ribs of the postero-dorsal area; interspaces are narrow and deep; lunule small but distictly impressed; the hinge armature is of the *megacardita*-type.

Lengh 12 mm; height 9.8 mm and breadth 3.8 mm (right valve) (type specimen)
Length 10.5 mm; height 8.9 mm and breadth 3.2 mm (left valve)
Length 10.0 mm; height 8.3 mm and breadth 3.0 mm (left valve)

Type locality: St. 494 (off Shimane Pref.).

Localities: St. 205 (Kumano-nada, 224 m); St. 222 (Tosa Bay, 210 m); Sts. 240, 251 and 255 (Sagami Bay, 192 m, 165 m and 263 m); St. 259 (Suruga Bay, 188 m); Sts. 439, 447 and 452 (off Gotô Islands, 155 m, 90 m and 154 m); Sts. 459 and 468 (off Tsushima, 115 m and 112 m); Sts. 481 and 484 (off Yamaguchi Pref., 143 m and 93 m); Sts. 491 and 494 (off Shimane Pref., 112 m and 110 m); St. 568 (off Noto Peninsula, 90 m) and St. 580 (Toyama Bay, 135 m).

Distribution: Kyushu: Shikoku and Honshu (north to Sagami Bay and Toyama Bay).

Remarks: This is somewhat close to the young form of *V.* (*M.*) *coreensis* (Deshayes), but has the scaly radials ribs on the postero-dorsal area.

144. *Venericardia* (*Megacardita*) *ferruginosa* (A. Adams et Reeve)

(Pl. I, fig. 22)

1850 *Cardita ferruginosa* A. Adams et Reeve, Voy. Samarang, Moll., p. 76, pl. 21, fig. 21.
1913 *Venericardia kiiensis* Sowerby, Ann. Mag. Nat. Hist., (8) 12, p. 238, pl. 3 fig. 14.
1920 *Venericardia cipangoana* Yokoyama, Jour. Coll. Sci. Imp. Univ. Tokyo, **39** (6), p. 137, pl. 11, fig. 2.

Localities: St. 4 (off Bôsô Peninsula, 287 m); St. 211 (off Tanabe, Wakayama

Pref., 190 m); St. 220 (Tosa Bay, 234 m) and St. 440 (off Gotô Islands, 152 m).

Distribution: Kyushu: Shikoku and Honshu (north to Bôsô Peninsula) and southern Korea.

145. *Cyclocardia ferruginea* (CLESSIN)

1888 *Cardita ferruginea* CLESSIN, Conchyl. Cab., **10** (1), p. 17, pl. 6, fig. 11.

Localities: Sts. 47, 53, 89, and 90 (off Iwate Pref., 355 m, 190 m, 124 m and 152 m); Sts. 78, 81 and 84 (off Shimokita Peninsula, 143 m 172 m and 171 m); St. 321 (Bungo Channel, 457 m); St. 429 (off Amakusa, 223); Sts. 439 and 452 (off Gotô Islands, 155 m and 154 m); Sts. 459, 462, 475 and 477 (off Tsushima, 115 m, 117 m, 192 m and 99 m); St. 478 (off Pusan, Korea, 101 m); Sts. 479 and 481 (off Urusan, Korea, 148 and 143 m); Sts. 495 and 498 (off Shimane Pref., 146 m and 139 m); St. 506 (off Oki Islands, 176 m) and Sts. 647 and 652 (off Tsugaru Peninsula, 86 m and 110 m).

Distribution: North-western Kyushu and Honshu (south to Sagami Bay) and Japan Sea.

Superfamily Glossacea

Family Vesicomyidae

145. *Vesicomya katsuae* KURODA

1952 *Vesicomya katsuae* KURODA, Jap. Jour. Malac. (Venus), **17**, p. 4, figs. 5–9.

Localities: St. 216 (off Kanno-ura, Kochi Pref., 274 m) and St. 302 (off Toi-zaki, Miyazaki Pref., 572 m).

Distribution: Shikoku and southern Kyushu.

Family Glossidae

146. *Meiocardia tetragona* (A. ADAMS et REEVE)

(Pl. I, fig. 5, 6)

1850 *Isocardia tetragona* A. ADAMS et REEVE, Voy. Samarang, Moll., p. 76, pl. 22, fig. 1.

Localities: St. 12 (off Chôshi, Chiba Pref., 325 m); Sts. 188, 259, 276 and 286 (Suruga Bay, 214 m, 188 m, 77 m, and 123); St. 300 and 301 (off Toizaki, Miyazaki Pref., 110 m and 181 m); Sts. 325 and 327 (off Uwajima, Ehime Pref., 210 m and 216 m); St. 340 (Tosa Bay, 481 m); St. 345 (off Muroto-zaki, Kôchi Pref., 165–199 m); St. 347 (off Kanno-ura, Kôchi Pref., 126 m); St. 376 (Enshû-nada, 64 m); St. 384 (the entrance of Ise Bay, 21–38 m); St. 417 (off Makura-zaki, Kagoshima, Pref., 192 m); St. 428 (off Amakusa, 119 m); Sts. 431, 432, 437, 439, 441, 445, 448, 451 (off Gotô Islands, 152 m, 148 m, 307 m, 155 m, 353 m, 73 m, 157 m, and 187 m); St. 455 (off Quelpart Island, 90 m); St. 466 (off Iki Island, 110 m); Sts. 468 and 469 (off Tsushima, 112 m and 91 m); Sts. 483 and 492 (off Yamaguchi Pref., 130 m and 132 m); St. 494 (off Shimane Pref., 110 m); Sts. 503 and 504 (off Oki Island, 146 m and 106 m); and St. 591 (off Niigata Pref., 311 m).

Distribution: East Indies; Kyushu; Shikoku and Honshu (north to Chôshi, Chiba Pref., and Niigata Pref.).

147. *Meiocardia moltkiana* (SPENGLER)

1783 *Isocardia moltokiana* SPENGLER, Schr. Berlin Ges. Naturf., **4**, p. 321, pl. 14, figs. 1–4.
1882 *Isocardia sanguinomaculata* DUNKER, Index Moll. Mar. Jap., p. 213.

Localities: St. 211 (off Tanabe, Wakayama Pref., 190 m); Sts. 444 and 445 (off Gotô Islands, 194 m and 73 m).

Distribution: East Indies; Philippines; China; Kyushu; Shikoku and Honshu (north to Sagami Bay).

Superfamily Lucinacea

Family Ungulinidae

148. *Joannisiella cumingii* (HANLEY)

1842 *Cyrenoidea cumingii* HANLEY, Cat. Rec. Biv. Shells, p. 353, pl. 15, fig. 5.

Localities: St. 479 (off Urusan, Korea, 148 m) and St. 646 (off Tsugaru Peninsula, 123 m).

Distribution: Formosa to Honshu.

149. *Joannisiella lunaris* (YOKOYAMA)

1927 *Diplodonta lunaris* YOKOYAMA, Jour. Fac. Sci. Imp. Univ. Tokyo, (2) **1** (10), p. 433, pl. 50, figs. 5, 6.

Localities: St. 4 (off Bôsô Peninsula, 287 m); St. 483 and 488 (off Yamaguchi Pref., 130 m and 480 m).

Distribution: Kyushu, Shikoku and Honshu.

Remarks: This species is very common in bays of Japan.

150. *Diplodonta gouldi* YOKOYAMA

1920 *Diplodonta gouldi* YOKOYAMA, Jour. Coll. Sci. Imp. Univ. Tokyo, **39** (6), p. 132, pl. 10, fig. 5.

Localities: St. 12 (off Chôshi, Chiba Pref., 325 m); St. 255 (Sagami Bay, 263 m);

St. 324 (off Uwajima, Ehime Pref., 106 m); and St. 600 (off Sado Island, 168 m).

151. *Felaniella usta* (GOULD)

1861 *Mysia* (*Felania*) *usta* GOULD, Proc. Boston Soc. Nat. Hist., 8, p. 32.
1929 *Felaniella oilvacea* BARTSCH, Inst. Hydrol. Explor. Meers U. S. S. R., p. 132, **10**, pl. 1, figs. 8–14.

Locality: St. 622 (off Akita Pref., 218 m) *fide* NOMURA et HATAI, 1935.
Distribution: Northern Honshu; Hokkaido; Saghalien; Korea and Siberia.

Family Thyasiridae

152. *Conchocele disjuncta* GABB

(Pl. II, fig. 5)

1866 *Conchocele disjuncta* GABB, Geol. Surv. Calif. Palaeo., **2**, p. 99, pl, 7, figs. 48 a, b.
1925 *Thyasira bisecta nipponica* YABE et HATAI (in part), Sci. Rep. Tohoku Imp. Univ., (2) **7** (4), p. 84, pl. 23, figs. 2, 8, 10.

Localities: St. 500 (off Shimane Pref., 642 m) and St. 514 (off Oki Island, 455 m).
Distribution: Alaska; Hokkaido and Japan Sea.

153. *Thyasira tokunagai* KURODA et HABE

1951 *Thyasira tokunagai* KURODA et HABE, Gen. Jap. Shells, **2**, p. 127, fig. 266.

Localities: St. 259 (Suruga Bay, 188 m); St. 437 (off Gotô Islands, 307 m); St. 459 (off Tsushima, 115 m); Sts. 492 and 495 (off Shimane Pref., 132 m and 146 m) and St. 580 (Toyama Bay, 135 m).
Distribution: North-western Kyushu, Honshu and Hokkaido.

154. *Thyasira* (*Philis*) *kanamarui* HABE

(Pl. I, figs. 23, 24)

1951 *Thyasira* (*Philis*) *kanamarui* HABE, Gen. Jap. Shells, **2**, p. 126, figs. 263–265.

Locality: St. 371 (off Atsumi Peninsula, 84 m).
Distribution: Honshu (Mie Pref. and Aichi Pref.).
Remarks: This species is also found in the Pleistocene deposit of Moeshima in Kagoshima Bay.

155. *Thyasira* (*Parathyasira*) *kawamurai* HABE

(Pl. I, fig. 27)

1951 *Thyasira* (*Parathyasira*) *kawamurai* HABE, Gen. Jap. Shells, **2**, p. 127, figs. 262.

Locality: St. 259 (Suruga Bay, 188 m).

Distribution: Honshu (Suruga Bay and Sagami Bay).

Remarks: This species is also found in the Pleistocene deposit of Moeshima in Kagoshima Bay.

156. *Axinopsida subquarata* (A. ADAMS)

(Pl. II, fig. 4)

1862 *Cryptodon* (*Clausina*) *subquadrata* A. ADAMS, Ann. Mag. Nat. Hist., (5) **9** (51), p. 227.

Localities: St. 479 (off Urusan, Korea, 148 m) and St. 483 (off Yamaguchi Pref., 130 m).

Distribution: Japan Sea; Hokkaido and northern Honshu.

Family Lucinidae

157. *Lucinoma annulata* (REEVE)

1850 *Lucina annulata* REEVE, Conch. Icon., sp. 17.

Localities: St. 11 (off Chôshi, Chiba Pref., 375 m); Sts. 249 and 255 (Sagami Bay, 249 m and 263 m); St. 205 (Kumano-nada, 224 m); Sts. 433, 437, 447 and 464 (off Gotô Islands, 168 m, 307 m, 90 m and 146 m); Sts. 471, 473 and 483 (off Yamaguchi Pref., 90 m, 143 m and 130 m); Sts. 474 (off Tsushima, 219 m); St. 478 (off Fusan, Korea, 101 m); St. 492 (off Shimane Pref., 132 m); St. 541 (off Yosa Peninsula, Kyoto Pref., 150 m) and St. 591 (off Niigata Pref., 311 m).

Distribution: Kyushu to Hokkaido; Alaska.

158. *Lucinoma yoshidai* sp. nov.

Shell white with the pale yellowish periostracum, rather flat, subquadrate in shape, rounded anteriorly and truncated posteriorly; beak small, oblique anteriorly, antero-dorsal margin recurved in front of the beak the postero-dorsal nearly straight; surface ornamented with the distantly placed and sharply lamellate riblets which are continuous over the whole surface; between the two riblets several weak growth lines are observed; a very weak flexure indicated on the postero-dorsal area; lunule elongated oval in shape, bordered by the sharp edges.

Length 24.2 mm; height 22.9 mm and breadth 4.6 mm (right valve) (type specimen)

Length 26.0 mm; height 25.2 mm and breadth 5.1 mm (right valve) (paratype specimen no. 1)

Length 25.0 mm; height 23.0 mm and breadth 5.4 mm (left valve) (paratype specimen no. 2)

Length 25.4 mm; height 22.5 mm and breadth 5.1 mm (left valve) (paratype spemen no. 3)

Type locality: St. 495 (off Shimane Pref.).

Localites: St. 475 (off Tsushima, 192 m); St. 479 (off Urusan, Korea, 148 m); Sts. 495 and 498 (off Shimane Pref., 146 m and 139 m).

Distribution: Southern part of Japan Sea.

Remarks: This new species is easily distinguished from *L. annulata* (REEVE) in having the very flat subquadrate shell on which the distantly placed lamellate lines are marked. The writer takes pleasure in naming this new species in honour of Dr. Hiroshi YOSHIDA who was a member of scientific staffs during this survey.

159. *Lucinoma adamsiana* sp. nov.

This new species is very similar to *Lucinoma yoshidai*, but in the former the shell is subquadrate in shape, truncated at the anterior and posterior ends, the surface of which marks the densely set concentric riblets all over and a distinct flexure on the postero-dorsal area. *L. annulata* is another allied species to this new species, but may be easily distinguished in the circular shell without a distinct flexure.

Length 15.5 mm; height 14.4 mm and 3.6 mm (left valve) (type specimen).

Type locality: St. 484 (off Yamaguchi Pref. 93 m).

160. *Lucinoma japonica* sp. nov.

Shell white orbicular, very inflated; beak small, oblique anteriorly; surface with concentric lamellae throughout; lunule narrow but distinctly excavated; two cardinal teeth in each valve; in the right valve the anterior cardinal teeth confuses with the dilation of anterior dorsal margin and the posterior one is small and in the left valve the anterior cardinal tooth is small and the posterior one is elongate posteriorly; the anterior muscle scar is long as in other lucinid species.

Length 13.9 mm; height 13.0 mm and breadth 7.0 mm (type specimen)

Length 13.9 mm; height 13.4 mm and breadth 3.7 mm (left valve) (paratype specimen)

Type locality: St. 481 (off Yamaguchi Pref.).

Localities: St. 481 (off Yamaguchi Pref., 143 m) and St. 492 (off Shimane Pref., 132 m).

This new species is easily separable from other species of the genus *Lucinoma* in having the circular inflated shell.

161. *Notomyrtea soyoae* HABE

(Pl. II, fig. 10)

1953 *Notomyrtea soyoae* HABE, Jap. Jour. Malac. (Venus), **17**, p. 131, figs. 8, 9.

Localities: St. 248 (Sagami Bay, 170 m); St. 433 (off Gotô Islands, 168 m); Sts.

481 and 486 (off Yamaguchi Pref., 143 m ane 139 m); and Sts. 492, 495 and 498 (off Shimane Pref., 132 m, 146 m, and 139 m).

Distribution: North-western Kyushu and the southern part of Japan Sea and Sagami Bay.

162. *Alucinoma soyoae* HABE

(Pl. II, figs. 16, 17)

1958 *Alucinoma soyoae* HABE, Jap. Jour. Malac., **19**, p. 178, 181, figs. 5, 6.

Locality: St. 498 (off Shimane Pref., 139 m).

Distribution: Off Shimane Pref. and Tosa Bay.

163. *Sydrolina yamakawai* (YOKOYAMA)

1920 *Lucina yamakawai* YOKOYAMA, Jour. Coll. Sci. Imp. Univ. Tokyo, **39** (6), p. 135, pl. 10, fig. 9.

Locality: St. 365 (off Hamashima, Mie Pref., 93 m).

Distribution: Kyushu; Shikoku and Honshu (north to Bôsô Peninsula).

164. *Wallucina lamyi* (CHAVAN)

1938 *Loripes* (*Wallucina*) *lamyi* CHAVAN, Jour. de Conchyl., **82**, p. 227.

1882 *Lucina contraria* DUNKER, Index Moll. Mar. Jap., p. 215, pl. 13, figs. 12–14 (*non* DUNKER, 1846).

Localities: St. 4 (off Bôsô Peninsula, 287 m); Sts. 483 and 484 (off Yamaguchi Pref., 130 m and 93 m); and Sts. 492 and 494 (off Shimane Pref., 132 m and 110 m).

Distribution: Kyushu; Shikoku and Honshu.

165. *Bellucina civica* (YOKOYAMA)

(Pl. II, fig. 3)

1927 *Cardium civicum* YOKOYAMA, Jour. Fac. Sci. Imp. Univ. Tokyo, (2) 2 (4), p. 179, pl. 48, figs. 3, 4.

Localities: St. 12 (off Chôshi, Chiba Pref., 325 m); St. 259 (Suruga Bay, 188 m); St. 365 (off Hamashima, Mie Pref., 93 m); Sts. 371 and 376 (Enshû-nada, 84 m and 64 m); Sts. 432, 433 and 452 (off Gotô Islands, 148 m, 168 and 154 m); Sts. 459, 466 and 468 (off Tsushima, 115 m, 110 m and 112 m); Sts. 482, 483 and 488 (off Yamaguchi Pref., 139 m, 130 m and 406 m); St. 493 (off Shimane Pref., 124 m) and St. 504 (off Oki Islands, 106 m).

Distribution: Kyushu; Shikoku and Honshu (north to Chôshi, Chiba Pref. and off Oki Islands).

166. *Ctena delicatula* (PILSBRY)

1904 *Codakia bella delicatula* PILSBRY, Proc. Acad. Nat. Sci. Phila., **56**, p. 555, pl. 41, figs. 15, 16.

Locality: St. 327 (off Uwajima, Ehime Pref., 216 m)
Distribution: Ryukyu; Kyushu; Shikoku and Honshu (north to Sagami Bay).

167. *Divalucina soyoae* (HABE)

(Pl. II, fig. 2)

1952 *Divaricella soyoae* HABE, Illust. Cat. Jap. Shells, **1** (22), p. 160.

Locality: St. 444 (off Gotô Islands, 194 m).
Distribution: Kyushu and Shikoku.

Superfamily Erycinacea

Family Erycinidae

168. *Soyokellia compressa* gen. et sp. nov.

Shell small, white, thin, oblong transversely, very compressed, very inequilateral, rounded at both ends; dorsal and ventral margins subparallel, surface marked only growth lines, beak small and a little pointed; anterior end shorter than the posterior; right valve with one anterior and two posterior teeth with a narrow resilifer between.

Length 5.5 mm, height 3.3 mm and 1.0 mm (right valve) (type specimen)

Type locality: St. 494 (off Shimane Pref., 110 m).

Remarks: The shell of this new species is characterized by the oblong shell which is strongly elongate anteriorly. The hinge teeth consists of three teeth as in the genus *Kellia*. The anterior teeth are long and lamellate and the middle one is solid and trigonal and the posterior one is narrow but not prominent. The resilifer between the posterior and middle teeth is rather narrow. By these features a new generic name is proposed to this new species. "*Mysella*" *oblongata* YOKOYAMA is very close to this new species in the shell appearance, but has different hinge teeth.

Superfamily Chamacea

Family Chamidae

169. *Chama dunkeri* LISCHKE

1870 *Chama dunkeri* LISCHKE, Mal. Bl., **17**, p. 27.

Locality: St. 445 (off Gotô Islands, 73 m).
Distribution: Ryukyu; Kyushu, Shikoku and Honshu (north to Bôsô Peninsula).

170. *Chama reflexa* REEVE

1846 *Chama reflexa* REEVE, Conch. Icon., sp. 16.

Localities: St. 11, (off Chôshi, Chiba Pref., 375 m); St. 292 (off Ôsumi Peninsula, 126 m); St. 327 (off Uwajima, Ehime Pref., 216 m); St. 345 (off Muroto-zaki, 166–199 m) and St. 444 (off Gotô Islands, 194 m).

Distribution: Formosa; Ryukyu; Kyushu; Shikoku and Honshu.

171. *Chama semipurpurata* LISCHKE

1870 *Chama semipurpurata* LISCHKE, Mal. Blatt., **17**, p. 27.

Locality: St. 4 (off Bôsô Peninsula, 287 m).

Distribution: Ryukyu; Kyushu; Shikoku and Honshu (north to Bôsô Peninsula).

172. *Chama argentata* KURODA et HABE sp. nov.

Shell small but solid, white to orange, pearly; the free valve orbicular in shape and lamellose; the beak turns to whether right or left; the sessile valve deep and strongly and sharply lamellate and twisted right or left.

Length 12.5 mm; height 11.8 mm and breadth 3.3 mm (left valve of type specimen)

Length 12.5 mm; height 12.9 mm and breadth 5.7 mm (right valve of type specimen)

Type locality: Tosa Bay, Shikoku (collected by Mr. A. TERAMACHI).

Localities: St. 218 (off Muroto-zaki, Kôchi Pref., 132 m) St. 327 (off Uwajima, Ehime Pref., 216 m) and St. 420 (off Koshiki Islands, Kagoshima Pref., 132 m).

Distribution: Kyushu; Shikoku and Honshu.

Remarks: This deep sea species is very characteristic in having the pearly shell on which distinct lamellae are placed distantly. The growth lines are lamellate but not fimbriate. The fixation is whether by the left valve or the right.

Superfamily Cardiacea

Family Cardiidae

173. *Laevicardium undatopictum* (PILSBRY)

1904 *Cardium hungerfordi undatopictum* PILSBRY, Proc. Acad. Nat. Sci. Phila., **56**, p. 556, pl. 40, fig. 14, 15.

1904 *Cardium hungerfordi stigmaticum* PILSBRY, *l, c.*, p. 556, pl. 41, figs. 13, 14.

Locality: St. 4 (off Bôsô Peninsula, 287 m).

Distribution: Kyushu: Shikoku and Honshu (north to Bôsô Peninsula and Toyama Bay).

174. *Fulvia mutica* (REEVE)

1844 *Cardium muticum* REEVE, Conch. Icon., sp. 32.
1860 *Cardium japonicum* DUNKER, Mal. Blatt., **6**, p. 223.
1904 *Cardium annae* PILSBRY, Proc. Acad. Nat. Sci. Phila., **56**, p. 557, pl. 40. fig. 20.

Locality: St. 248 (Sagami Bay, 170 m).

Distribution: China; Korea; Ryukyu; Kyushu; Shikoku and Honshu.

175. *Clinocardium californiense* (DESHAYES)

1839 *Cardium californiense* DESHAYES, Rev. Zool. Soc. Cuv. **2**, p. 360.

Localities: Sts. 439 and 440 (off Gotô Islands, 155 m and 152 m); Sts. 459 and 475 (off Tsushima, 115 m and 192 m); St. 481 (off Urusan, Korea, 143 m); and St. 634 (off Oga Peninsula, 84 m).

Distribution: Maritime Prov. of Siberia; Korea; Kamtchatka; Saghalien; Kuriles; Hokkaido; Honshu and north-western Kyushu.

176. *Keenaea samarangae* (MAKIYAMA)

(Pl. I, fig. 29)

1850 *Cardium modestum* A. ADAMS et REEVE, Voy. Samarang, Moll., p. 77, pl. 22, fig. 6 (*non* PHILIPPI 1849).
1872 *Cardium adamsi* TRYON, Amer. Jour. Conch., **7**, p. 267, (*non* A. ADAMS et REEVE 1850),
1934 *Cardium samarangae* MAKIYAMA, Mem. Coll. Sci. Kyoto Imp. Univ., (B) **10** (2), p. 143.

Localities: Sts. 11 and 12 (off Chôshi, Chiba Pref., 375 m and 325 m); St. 212 (off Tanabe, Wakayama Pref., 181 m); Sts. 240, 241 and 255 (Sagami Bay, 192 m 476 m and 263 m); Sts. 259, 276, 279 and 286 (Suruga Bay, 188 m, 77 m, 155 m and 123 m); Sts. 322 (Bungo Channel, 110 m); Sts. 329 and 331 (off Ashizuri-zaki, Kochi Pref., 296 m and 344 m); St. 347 (off Kanno-ura. Kochi Pref., 126 m); Sts. 371 and 377 (Enshû-nada, 84 m and 82 m); St. 425 (off Koshiki Islands, 300 m); Sts. 432, 433, 437, 439, 441 and 448 (off Gotô Islands, 148 m, 168 m, 307 m, 155 m, 353 m and 157 m); St. 455 (off Quelpart Island, 90 m); Sts. 457, 459, 468, 474, 475, and 477 (off Tsushima, 112 m, 115 m, 112 m, 219 m 192 m and 99 m); Sts. 479 and 481 (off Urusan, Korea, 148 m and 143 m); Sts. 484, 486 and 488 (off Yamaguchi Pref., 93 m, 139 m and 406 m); Sts. 491, 492, 493, 494, 495, 497, 498 (off Shimane Pref., 112 m, 132 m, 124 m, 110 m, 146 m, 143 m, and 139 m); Sts. 503, 504 and 512 (off Oki Islands, 146 m, 106 m and 141 m); Sts. 517, 523 and 530 (off Tottori Pref., 214 m 181 m and 183 m); Sts. 540 and 541 (off Yosa Peninsula, Kyoto Pref., 123 m and 150 m); Sts. 572 and 575 (off Noto Peninsula, 132 m and 123 m); St. 608 (off Sado Island, 150 m) and Sts. 622, 634 and 639 (off Akita Pref., 218 m, 84 m and 196 m).

Distribution: Kyushu; Shikoku and Honshu (north to Bôsô Peninsula and Oga Peninsula).

177. *Frigidocardium eos* (Kuroda)

(Pl. II, fig. 1)

1929 *Cardium eos* Kuroda, Venus, **1**, p. 93, pl. 3, fig. 5.

Localities: St. 4 (Bôsô Peninsula, 287 m); St. 221 (off Tosa Bay, 209); Sts. 259, 284 and 286 (Suruga Bay, 188 m, 71 m and 123 m); St. 300 (off Toi-zaki, Miyazaki Pref., 110 m); St. 365 (off Hamashima, Mie Pref., 93 m); St. 322 (Bungo Channel, 110 m); Sts. 431, 438, 439, 440, 444, 445, 447, 449 (off Gotô Islands, 152 m, 219 m, 155 m, 152 m, 194 m, 73 m, 90 m and 155 m); St. 466 (off Tsushima, 110 m); St. 469 (off Iki Island, 91 m); St. 471 (off Yamaguchi Pref., 90 m) and St. 494 (off Shimane Pref., 110 m).

Distribution: Kyushu; Shikoku and Honshu (north to Bôsô Peninsula and off Shimane Pref.).

178. *Frigidocardium exasperatum* (Sowerby)

1841 *Cardium exasperatum* Sowerby, Proc. Zool. Soc. London, p. 106 (1840).

Locality: St. 220 (off Tosa Bay, 234 m); St. 345 (off Muroto-zaki, Kôchi Pref., 165–199 m) and St. 438 (off Gotô Islands, 219 m).

Distribution: China; Formosa; Kyushu; Shikoku and Honshu (Wakayama Pref.).

179. *Trifaricardium nomurai* Kuroda et Habe

(Pl. II, fig. 18)

1933 *Cardium cancellata* Nomura, Sci. Rep. Tohoku Imp. Univ., (2) **16** (1), p. 81, pl. 3, figs. 9 a, b (*non* Gmelin 1791).

1951 *Trifaricardium nomurai* Kuroda et Habe, Illust. Cat. Jap. Shells, **1** (13), p. 86.

Localities: St. 440 (off Gotô Islands, 152 m).

Distribution: Gotô Islands, Kyushu and Tosa Bay, Shikoku.

Superfamily Veneracea

Family Veneridae

180. *Circe* (*Redicirce*) *nana* Melvill

(Pl. I, fig. 7, 8)

1898 *Circe nana* Melvill, Mem. Manchester Lit. Soc., **42** (2), p. 31, pl. 2, fig. 9.

1931 *Circe salamensis* Thiele et Jaeckel, Deutsch. Tiefsee Exped., **21** (1), p. 233, pl. 4, fig. 106.

Localities: St. 12 (off Chôshi, Chiba Pref., 325 m); St. 220 (Tosa Bay, 234 m); St. 270 (Sagami Bay, 91 m); Sts. 276, 279 and 286 (Suruga Bay, 77 m, 155 m, and

73 m); St. 300 (off Toi-zaki, Miyazaki Pref., 110 m); St. 322 (Bungo Channel, 110 m); St. 345 (off Muroto-zaki, Kôchi Pref., 165–199 m); St. 347 (off Kannoura, Kôchi Pref., 126 m); St. 363 (off Owase, Mie Pref., 439 m); St. 376 (Enshû-nada, 64 m); St. 417 (off Makurazaki, Kagoshima Pref., 192 m); Sts. 432, 441, 445 and 452 (off Gotô Islands, 148 m, 353 m, 90 m and 154 m); St. 457 (Tsushima Strait, 112 m); St. 466 (off Iki Island, 110 m); Sts. 468, 474 and 475 (off Tsushima, 112 m 219 m and 192 m); St. 470 (off Fukuoka Pref., 73 m); St. 481 (off Urusan, Korea, 143 m) Sts. 498, 520 and 521) (off Shimane Pref., 139 m, 75 m and 86 m) and St. 523 (off Tottori Pref., 181 m).

181. *Microcirce gordonis* (YOKOYAMA)

(Pl. I, figs. 3, 4)

1927 *Meretrix gordonis* YOKOYAMA, Jour. Fac. Sci. Imp. Univ. Tokyo, (92) **1** (10), p. 429, pl. 48, fig. 14 only.

Localities: St. 4 (off Bôsô Peninsula, 287 m); St. 447 (off Gotô Islands, 90 m); St. 521 (off Shimane Pref., 86 m); Sts. 459, 462 and 468 (off Tsushima, 115 m, 117 m and 112 m) and St. 483 (off Yamaguchi Pref., 130 m).

Distribution: Kyushu; Shikoku; Honshu and southern Hokkaido.

182. *Laevicirce soyoae* HABE

(Pl. I, figs. 10, 11)

1951 *Laevicirce gordonis* HABE, Gen. Jap. Shells, **2**, p. 160, figs. 353–355.

Localities: St. 452 (off Gotô Islands, 154 m); Sts. 459 and 475 (off Tsushima, 115 m and 192 m); St. 466 (off Iki Island, 110 m) and St. 481 (off Urusan, Korea, 143 m).

Distribution: Gotô Islands and Tsushima Strait.

183. *Pitar* (*Pitarina*) *affine* (GMELIN)

1791 *Venus affinis* GMELIN, Syst. Nat. ed. **13**, p. 3278.
1851 *Cytherea inflata* SOWERBY, Thes. Conch., **2**, p. 637, pl. 133, fig. 127.

Localities: St. 205 (Kumano-nada, 224 m); St. 276 (Suruga Bay, 77 m); St. 447 (off Gotô Islands, 90 m); St. 468 (off Tsushima, 112 m); St. 481 (off Urusan, Korea, 143 m); Sts. 491 and 498 (off Shimane Pref., 112 m and 139 m) and St. 580 (Toyama Bay, 135 m).

Distribution: Widely distributed in the Indo-Pacific region; Kyushu; Shikoku and Honshu. (north to Kashima-nada, Ibaragi Pref. and Toyama Bay).

184. *Pitar* (*Agriopoma*) *noguchii* sp. nov..

Shell thin, inflated, ashy white, trigonally ovate, slightly truncated posteriorly;

surface ornamented by the growth lines only and covered by the tiny sand grains all over; lunule widely cordate, defined by the impressed line.

Length 21.7 mm., height 18.2 mm, and breadth 13.2 mm (type specimen)

Type locality: Off Hamamatsu, Shizuoka Pref., Honshu (collected by Mr. H. NOGUCHI).

Localites: St. 468 (off Tsushima, 112 m) and St. 483 (off Shimane Pref., 130 m).

Distribution: Kyushu; Shikoku and Honshu (north to Sagami Bay).

Remarks: This new species is very close to *P.* (*A.*) *japonica* KURODA et KAWAMOTO, but the former has an ashy white, thin shell with a very broad lunule, while the latter has a light orange shell with a less broad lunule.

185. *Pitar* (*Costellipitar*) *chordatum* (ROEMER)

(Pl. II, figs. 19, 20)

1867 *T. chordata* ROEMER, Mon. Venus, **1**, p. 125, pl. 33, fig. 2.

1940 *Pitar hukaurensis* NOMURA et HATAI, Saito Hô-on Kai Mus. Res. Bull. **19**, p. 83, pl. 4, figs. 10 a, b.

Locality: St. 211 (off Tanabe, Wakayama Pref., 190 m).

Distribution: Kyushu; Shikoku and Honshu.

186. *Callista brevisiphonata* (CARPENTER)

1865 S*axidomus brevisiphonatus* CARPENTER, Proc. Zool. Soc. London, p. 203.

1905 *Macrocallista chishimana* PILSBRY, Proc. Acad. Nat. Sci. Phila., **57**, p. 118.

Localities: St. 57 (off Iwate Pref., 494 m).

Distribution: Northern Honshu; Hokkaido; Saghalien; Kuriles; Siberia.

187. *Callista chinensis* (HOLTEN)

1803 *Venus chinensis* HOLTEN, Enum. Syst. Conchyl., p. 20.

1818 *Venus* pacifica DILLWYN, Descript. Cat., **1**, p. 175.

1855 *Cytherea sinensis* SOWERBY, Thes. Conch., **2**, p. 624, pl. 131, figs. 80, 81.

1864 *Dione festiva* REEVE, Conch. Icon., sp., 4.

Localities: St. 4 (off Bôsô Peninsula, 287 m); St. 188 (Suruga Bay, 214 m); Sts. 211 and 352 (off Tanabe, Wakayama Pref., 190 m and 154 m); St. 274 (off Omae-zaki, Shizuoka Pref., 51 m); St. 298 (off Toi-zaki, Miyazaki Pref., 117 m); St. 371 (Enshu nada, 84 m); Sts. 484 and 488 (off Yamaguchi Pref., 93 m and 406 m) and St. 519 (off Tottori Pref., 81 m).

Distribution: China; Formosa; Kyushu; Shikoku and Honshu (north to Bôsô Peninsula and Toyama Bay).

188. *Sunetta* (*Cyclosunetta*) *menstrualis* (MENKE)

1843 *Cytherea menstrualis* MENKE, Moll. Nov. Holl., sp. 43.
1843 *Cytherea excavata* REEVE, Proc. Zool. Soc. London, p. 123 (*non* MORTON 1834).
1864 *Meroe magnifica* REEVE, Conch. Icon., sp. 2.

Localities: St. 255 (Suruga Bay, 263 m) and Sts. 440 and 452 (off Gotô Islands, 152 m and 154 m).

Distribution: Widely distributed in the Indo-Pacific region; Kyushu; Shikoku and Honshu (north to Bôsô Peninsula).

189. *Sunetta* (*Cyclosunetta*) *subquadrata* (SOWERBY)

1851 *Meroe subquadrata* SOWERBY, Thes. Conch., 2, p. 610, pl. 126, fig. 9.

Localities: St. 286 (Suruga Bay, 123 m) and St. 325 (off Uwajima, Ehime Pref., 210 m).

Distribution: Kyushu; Shikoku and Honshu (north to Suruga Bay).

190. *Dosinia* (*Phacosoma*) *pubescens* (PHILIPPI)

1847 *Cytherea pubescens* PHILIPPI, Abbild. Beschr., 3, p. 26, pl. 8, fig. 3.

Locality: St. 284 (Suruga Bay, 71 m); St. 468 (off Tsushima, 112 m); Sts. 481 and 483 (off Yamaguchi Pref., 143 m and 130 m); St. 492 (off Shimane Pref., 132 m) and Sts. 617 and 639 (off Akita Pref., 106 m and 196 m).

Distribution: Kyushu; Shikoku and Honshu.

191. *Dosinia* (*Phacosoma*) *troscheli* LISCHKE

1873 *Dosinia troscheli* LISCHKE, Mal. Blatt., 21, p. 24.

Locality: St. 329 (off Uwajima, Ehime Pref., 296 m).

Distribution: Kyushu; Shikoku and Honshu; southern Korea and North China.

192. *Dosinia* (*Bonartemis*) *iwakawai* OYAMA (MS).

Locality: St. 4 (off Bôsô Peninsula, 287 m).

Distribution: Kyushu; Shikoku and Honshu.

Remarks: This new species yet undescribed resembles *D.* (*B.*) (*histrio* (GMELIN) in shell appearance.

193. *Venus* (*Ventricolaria*) *toreuma* GOULD

(Pl. II, fig. 8)

1850 *Venus toreuma* GOULD, Proc. Boston Soc. Nat. Hist., 3, p. 277.
1853 *Venus jukesi* DESHAYES, Cat. Conch. Brit. Mus., p. 100.
1853 *Venus sculpta* DESHAYES, Proc. Zool. Soc. London, p. 3.

Localities: St. 327 Uwajima, Ehime Pref., 216 m) and St. 445 (off Gotô Islands, 73 m).

Distribution: Widely distributed in the Indo-Pacific region, Kyushu; Shikoku and Honshu.

194. *Venus* (*Ventricoloidea*) *foveolata* SOWERBY

(Pl. II, fig. 20)

1853 *Venus forveolata* SOWERBY, Thes. Conch., 2, p. 730, pl. 154, fig. 46.

Localities: St. 12 (off Chôsli, Chiba Pref., 325 m) Sts. 188 and 377 (off Omae-zaki, 214 m and 82 m); St. 193 (Enshû-nada, 265 m); Sts. 211 and 352 (off Tanabe, Wakayama Pref., 190 m and 154 m); Sts. 220, 221, 222, 340 and 342 (Tosa Bay, 234 m, 209 m, 210 m, 481 m and 288–527 m); Sts. 248 and 249 (Sagami Bay, 170 m and 229 m); Sts. 259, 275, 279, 286 and 383 (Suruga Bay, 188 m, 62 m, 155 m, 123 m and 353 m); St. 300 (off Toizaki, Miyzaki Pref., 110 m); Sts. 309 and 319 (off Miyazaki Pref., 472 m and 210 m); St. 345 (off Muroto-zaki, Kôchi Pref., 165–199 m); St. 347 (off Kannoura, Kôchi Pref., 126 m); Sts. 365 and 366 (off Hamashima, Mie Pref., 93 m and 494 m); St. 392 (Kii Channel, 152 m); St. 431 (off Amakusa, 152 m); Sts. 432, 433, 445, 448 and 452 (off Gotô Islands, 148 m, 168 m, 73 m, 157 m and 154 m); Sts. 457 and 458 (Tsushima Strait, 112 and 81 m); Sts. 459, 462, 466 and 468 (off Tsushima, 115 m, 117 m, 110 m and 112 m); St. 470 (off Hakata Bay, Fukuoka Pref., 73 m); St. 476 (off Pusan, Korea, 84 m); St. 481 (off Urusan Korea, 143 m); St. 483 (off Yamaguchi Pref., 130 m); Sts. 491, 492, 493 and 494 (off Shimane Pref., 112 m, 132 m, 124 m and 110 m); Sts. 503 and 504 (off Oki Islands, 146 m and 106 m) and St. 546 (Wakasa Bay, 101 m).

195. *Placamen tiara* (DILLWYN)

(Pl. II, fig. 7)

1817 *Venus tiara* DILLWYN, Descript. Cat., 1, p. 162.
1846 *Venus foliacea* PHILIPPI, Abbild. Beschr., 2 (4), p. 107, pl. 5, fig. 1.

Localities: St. 4 (Bôsô Peninsula, 287 m); St. 211 (off Tanabe, Wakayama Pref., 190 m); St. 298 (off Toi zaki, Miyazaki Pref., 117 m); St. 322 (Bungo Channel, 110 m); St. 470 (off Hakata Bay, Fukuoka Pref., 73 m); Sts. 484 and 488 (off Yamaguchi Pref., 93 m and 406 m) and St. 494 (off Shimane Pref., 110 m).

196. *Callanaitis hiraseana* KURODA

(Pl. II, fig. 12)

1930 *Callanaitis hiraseana* KURODA, Venus, 2, p. 2, text-fig. 1.

Locality: St. 345 (off Muroto-zaki, 165–199 m).

Distribution: Ryukyu; Kyushu; Shikoku and Honshu (Wakayama Pref.).

197. *Veremolpa minuta* (Yokoyama)

1820 *Chione minuta* Yokoyama, Jour. Coll. Sci. Imp. Univ. Tokyo, **39** (6), p. 122, pl. 8, fig. 14.

Localities: St. 4 (Bôsô Peninsula, 287 m); St. 24 (off Fukushima Pref., 428 m); St. 211 (off Tanabe Bay, Wakayama Pref., 190 m); St. 276 (Suruga Bay, 77 m); St. 300 (off Toi-zaki, Miyazaki Pref., 110 m); St. 324 (off Uwajima, Ehime Pref., 106 m); St. 345 (off Muroto-zaki, Kôchi Pref., 165-199 m); Sts. 432, 436 and 447 (off Gotô Islands, 148 m, 549 m and 90 m); St. 470 (off Hakata Bay, Fukuoka Pref., 73 m); Sts. 484 and 488 (off Yamaguchi Pref., 93 m and 406 m) and Sts. 494, 498 and 520 (Off Shimane Pref., 110 m, 139 m and 75 m).

Distribution: Kyushu; Shikoku and Honshu.

198. *Veremolpa mindanensis* (Smith)

1885 *Venus* (*Chione*) *mindanensis* Smith, Chall. Rep. Lamellibr., p. 130, pl. 3, figs. 4, a, b.

Localities: Sts. 220, 221 and 222 (Tosa Bay, 234 m, 209 m and 210 m); St. 259 (Suruga Bay, 188 m); Sts. 298 and 304 (off Toi-zaki, Miyazaki, Pref., 117 m and 241 m) and St. 483 (off Yamaguchi Pref., 279 m).

Distribution: East Indies; Philippines; Kyushu; Shikoku and Honshu (north to Suruga Bay and off Yamaguchi Pref.).

199. *Gomphina neastartoides* (Yokoyama)

1922 *Venus neastartoides* Yokoyama, Jour. Coll. Sci. Imp. Univ. Tokyo, **44** (1), p. 149, pl. 11, figs. 10, 11.

Locality: 392 (Kii Channel, 61 m).

Distribution: Kyushu and Honshu.

200. *Liocyma aniwana* Dall

(Pl. II, fig. 9)

1907 *Liocyma aniwana* Dall, Smiths. Misc. Coll., **50**, p. 172.

Localities: St. 487 (off Yamaguchi Pref., 194 m) and St. 652 (Tsugaru Strait, 110 m).

Distribution: Siberia; Saghalien; Kuriles; Hokkaido and Japan Sea.

201. *Liocyma beckii* Dall

1870 *Liocyma beckii* Dall, Proc. Boston Soc. Nat. Hist., **13**, p. 257.

Localities: St. 10 (off Chôshi, Chiba Pref., 205 m) and St. 152 (off Iwate Pref., 377 m).

Distribution: East coast of Honshu.

202. *Callithaca adamsi* (REEVE)

1863 *Venus adamsi* REEVE, Conch. Icon., sp. 77.

Locality: St. 475 (off Tsushima, 192 m).

Distribution: Saghalien; Kuriles; Hokkaido; North-east coast of Honshu; Korea and Siberia.

203. *Protothaca jedoensis* (LISCHKE)

1874 *Venus jedoensis* LISCHKE, Jahrb. Deutsch. Malak. Ges., **1**, p. 57.
1901 *Venus hirasei* PILSBRY, Proc. Acad. Nat. Sci. Phila., **53**, pp. 205, 400, pl. 19, fig. 1 and pl. 20, fig. 20.

Locality: St. 468 (off Tsushima, 112 m).

Distribution: North China; Korea; Kyushu; Shikoku; Honshu and southern Hokkaido.

204. *Tapes* (*Amygdala*) *japonica* DESHAYES

1853 *Tapes japonica* DESHAYES, Cat. Conch. Brit. Mus., p. 181.
1864 *Tapes semidecussata* REEVE, Conch. Icon., sp. 67.

Localities: St. 12 (off Chôshi, Chiba Pref., 325 m) and St. 468 (off Tsushima, 112 m).

Distribution: North China; Korea; Kyushu; Shikoku; Honshu; Hokkaido, Saghalien and Siberia.

205. *Paphia euglypta* (PHILIPPI)

1847 *Venus euglypta* PHILIPPI, Zeitschr. Malak., p. 89.

Localities: St. 4 (off Bôsô Peninsula, 287 m) and St. 248 (Sagami Bay. 170 m).

Distribution: Kyushu; Shikoku; Honshu and Korea.

206. *Paphia schnelliana* (DUNKER)

1866 *Tapes schelliana* DUNKER, Novit. Conch., p. 75, pl. 25, figs. 7–9.

Locality: St. 493 (off Shimane Pref., 124 m).

Distribution: Kyushu; Shikoku and Honshu (north to Bôsô Peninsula and Noto Peninsula).

207. *Paphia amabilis* (PHILIPPI)

1847 *Venus amabilis* PHILIPPI, Zeitschr. Malak., p. 90.

Locality: St. 4. (Off Bôsô Peninsula, 287 m).

Distribution: Kyushu; Shikoku and Honshu.

208. *Paphia vernicosa* (GOULD)

1861 *Tapes vernicosa* GOULD, Proc. Boston Soc. Nat. Hist., **8**, p. 30.
1877 *Tapes greefei* DUNKER, Malak. Blatt., **24**, p. 73.

Localities: St. 483 (off Yamaguchi Pref., 130 m).
Distribution: Kyushu; Shikoku and Honshu (north to Bôsô Peninsula).

209. *Clementia vatheleti* MABILLE

1901 *Clementia vatheleti* MABILLE, Bull. Philom. Paris, (8) **3**, p. 57.

Locality: St. 440 (Gotô Islands, 152 m) and St. 476 (off Pusan, Korea, 84 m).
Distribution: Kyushu; Shikoku; Honshu and Korea.

210. *Irus mitis* (DESHAYES)

1854 *Venerupis mitis* DESHAYES, Proc. Zool. Soc. London, p. 5 (1853).
1882 *Venerupis semipurpurata* DUNKER, Index Moll. Mar. Japan., p. 208.

Locality: St. 468 (off Tsushima, 112 m).
Distribution: Formosa; Kyushu; Shikoku and Honshu.

Family Petricolidae

211. *Lajonkairia divaricata* (LISCHKE)

(Pl. II, fig. 6)

1872 *Lucinopsis divaricata* LISCHKE, Malak. Blatt., **19**, p. 108.

Localities: St. 4 (off Bôsô Peninsula, 287 m).
Distribution: Kyushu; Shikoku and Honshu.

Superfamily Tellinacea

Family Gariidae

212. *Gari anomala* (DESHAYES)

1855 *Psammobia anomala* DESHAYES, Proc. Zool. Soc. London, p. 320.

Localities: St. 432 (off Gotô Islands, 148 m); St. 468 (off Tsushima, 112 m); St. 470 (off Hakata Bay, Fukuoka Pref., 73 m) and St. 483 (off Yamaguchi Pref., 130 m).
Distribution: Kyushu; Shikoku; Honshu and Philippines.

213. *Gari hosoyai* sp. nov.

This new species closely resembles *Gari radiata* DUNKER in shape and colouration, but the former has densely set oblique threads on the surface, while in the latter, the oblique threads are quite missing and the growth lines on the postero-dorsal area are distinctly marked. Also the former is smaller than the latter even in the adult stage. The specific name is dedicated to the late Mr. Kakujiro HOSOYA who had collected this interesting species from Sagami Bay.

Length 29.7 mm, height 15.0 mm and breadth 7.3 mm (type specimen)

Length 29.7 mm, height 14.7 mm and breadth 8.0 mm (paratype specimen)

Type locality: Sagami Bay (collected by Mr. K. HOSOYA).

Locality: St. 4 (Bôsô Peninsula, 287 m).

Distribution: Kyushu; Shikoku and Honshu (north to Bôsô Peninsula).

214. *Psammocola kazusensis* (YOKOYAMA)

1922 *Psammobia kazusensis* YOKOYAMA, Jour. Coll. Sci. Imp. Univ. Tokyo, **44** (1), p. 136, pl. 9, fig. 4.

Locality: St. 78 (off Shiriya-zaki, Shimokita Peninsula, 102 m).

Distribution: Hokkaido and northern Honshu.

Family Semelidae

215. *Abra kyurokusimana* (NOMURA et HATAI)

1940 *Tellina* (*Arcopagia*) *kyurokusimana* NOMURA et HATAI, Saitô Hô-on Kai Mus. Res. Bull., **19**, p. 85, pl. 4, figs. 16 a–c.

Localities: Sts. 259 and 286 (Suruga Bay, 188 m and 123 m); St. 252 (Sagami Bay, 286 m) and St. 295 (off Tanegashima, 154 m).

Distribution: Kyushu; Shikoku and Honshu.

Remarks: This species has been reported as a member of the tellinid genus *Arcopagia*, but this has an internal ligamental groove on the hinge plate. Therefore it should be transferred to this semelid genus.

216. *Abra soyoae* sp. nov.

(Pl. I, figs. 12, 13)

Shell thin, white or light yellow, smooth and polished, ovate, roundedly produced anteriorly and obliquely truncated posteriorly, moderately inflated; beak small but pointed; the antero-dorsal margin longer than the postero-dorsal; the hinge plate with two cardinal teeth and in the right valve anterior and posterior lateral teeth present far from the cardinal ones, the anterior tooth being stronger than the posterior; mantle line with a deep sinus.

Length 12.2 mm, height 9.2 mm, and breadth 5.6 mm (conjoined valves) (type specimen)

Type locality: St. 452 (off Gotô Islands, 154 m).

Localities: St. 304 (off-Toi zaki, Miyazaki Pref., 241 m); St. 321 (off Miyazaki Pref., 457 m) and Sts. 436 and 452 (off Gotô Islands, 549 m and 154 m).

Distribution: Kyushu and Shikoku.

Remarks: This shell is very close to that of *Abrina sibogai* PRASHAD in shape, but the former has the distinct lateral teeth on the right valve.

217. *Abra fujitai* sp. nov.

Shell rather small, white, smooth and polished, elongate ovate, rounded anteriorly and attenuated posteriorly and pointed at the posterior end, subequilateral, inflated; beak situated at about middle of the dorsal margin, ventral margin gently arcuated; hinge plate with two cardinal teeth and a ligamental groove and in the right valve the lamellate lateral teeth present distinctly, parallel to the dorsal margin.

Length 9.9 mm, height 7.2 mm and breadth 4.5 mm (type specimen)
Length 9.7 mm, height 6.9 mm and breadth 4.2 mm (paratype specimen)
Length 8.5 mm, height 6.2 mm and breadth 3.9 mm (paratype specimen)

Type locality: Tosa Bay, Shikoku (collected by Mr. A. TERAMACHI).

Locality: St. 452 (off Gotô Islands, 154 m).

Distribution: Kyushu and Shikoku.

Remarks: This new species is characterized by the inflated shell which is pointed at the posterior end. *Abrina inanis* PRASHAD is an allied form, but has the less inflated shell which has no lateral tooth.

218. *Abrina sibogai* (PRASHAD)

1932 *Abra sibogai* PRASHAD, Siboga Exped., Lamellibr., p. 200, pl. 6, figs. 1, 2.

Locality: St. 391 (off Miyazaki Pref., 84 m).

Distribution: East Indies; Kyushu; Shikoku and Honshu.

219. *Abrina kinoshitai* KURODA et HABE sp. nov.

Shell thin, white, smooth and polished, iridescens, elongated ovate, inequilateral, strongly produced to the rounded anterior end and attenuated to the posterior end; beak small and pointed, antero-dorsal margin slightly curved and longer than the nearly straight postero-dorsal; ventral margin gently curved; hinge plate weak and with two small cardinal teeth and a distinct ligamental groove on each valve, without any lateral tooth; mantle line with a deep sinus.

Length 12.4 mm, height 7.9 mm and breadth 1.7 mm (right valve) (type specimen)

Length 10.7 mm, height 6.6 mm and breadth 1.5 mm (right valve) (paratype specimen)

Length 10.6 mm, height 6.6 mm and breadth 1.5 mm (left valve) (paratype specimen)

Type locality: St. 371 (off Miyazaki Pref., 84 m).

Localities: St. 371 (off Miyazaki Pref., 84 m); St. 475 (off Tsushima, 192 m) and St. 483 (off Yamaguchi Pref., 130 m).

Distribution: Kyushu; Shikoku and Honshu.

Remarks: This species is named in honour of Dr. Toraichiro KINOSHITA who had firstly collected this interesting species from off Wakayama Pref., Honshu.

Family Tellinidae

220. *Cadella delta* (YOKOYAMA)

1922 *Tellina delta* YOKOYAMA, Jour. Coll. Sci. Imp. Univ. Totyo, **44** (1), p. 141, pl. 10, figs. 8–10.

Localities: St. 452 (off Gotô Islands, 154 m) and St. 459 (off Tsushima, 115 m).

Distribution: Kyushu; Shikoku and Honshu.

221. *Cadella lubrica* (GOULD)

(Pl. II, fig. 25)

1861 *Tellina lubrica* GOULD, Proc. Boston Soc. Nat. Hist., **8**, p. 28.

1935 *Tellina kesenensis* NOMURA et HATAI, Saitô Hô-on Kai Mus. Res. Bull., **5**, p. 15, pl. 1, figs. 1 a, b.

Localities: St. 479 (off Urusan, Korea, 148 m) and St. 495 (off Shimane Pref., 146 m).

Distribution: Hokkaido and northern Honshu; Japan Sea and Siberia.

222. *Merisca tokunagai* IKEBE

1936 *Arcopagia* (*Merisca*) *tokunagai* IKEBE, Venus, **6** (4), p. 203, fig. 3.

Localities: St. 248 (Sagami Bay, 170 m); St. 428 (off Amakusa, 119 m); St. 441 (off Gotô Islands, 353 m); St. 481 (off Tsushima, 143 m); St. 491 (off Yamaguchi, 112 m) St. 495 (off Shimane Pref., 146 m) and St. 541 (off Yosa Peninsula, Kyoto Pref., 150 m).

Distribution: Kyushu; Shikoku and Honshu (north to Sagami Bay and Wakasa Bay).

223. *Merisca margaritina* (LAMARCK)

1818 *Tellina margaritina* LAMARCK, Anim s. Vert., **5**, p. 525.

1905 *Tellina serricostata* TOKUNAGA, Jour. Coll. Sci Imp. Univ. Tokyo, **21**, p. 43, pl. 2, figs. 32 a, b.

Localities: St. 12 (Chôshi, Chiba Pref., 325 m); Sts. 211 and 352 (off Tanabe, Wakayama Pref., 190 m and 154 m); St. 221 (Tosa Bay, 209 m); St. 298 (off Toi-zaki, Miyazaki Pref., 117 m); St. 365 (off Hamashima, Mie Pref., 93 m); St. 377 (off Omaezaki, Shizuoka Pref., 82 m); St. 432 (off Gotô Islands, 148 m); St. 466 (off Iki Island, 110 m); St. 470 (off Hakata Bay, Fukuoka Pref., 73 m); St. 481 (off Urusan, Korea, 143 m); Sts. 483, 484 and 488 (off Yamaguchi Pref., 130 m, 93 m and 406 m); Sts. 494, 497 and 520 (off Shimane Pref., 110 m, 143 m and 75 m) and St. 523 (off Tottori Pref., 181 m).

Distribution: Kyushu; Shikoku and Honshu.

224. *Merisca subtruncata* (HANLEY)

1844 *Tellina subtruncata* HANLEY, Proc. Zool. Soc. London, p. 149.
1906 *Tellina ojiensis* TOKUNAGA, Jour. Coll. Sci. Imp. Univ. Tokyo, **21** (2), p. 44, pl. 2, fig. 34.

Locality: St. 4 (off Bôsô Peninsula, 287 m).

Distribution: Kyushu; Shikoku and Honshu.

225. *Elliptotellina fabrefacta* (PILSBRY)

(Pl. I, fig. 21)

1904 *Tellina fabrefacta* PILSBRY, Proc. Acad. Nat. Sci. Phila., **56**, p. 555, pl. 41, figs. 11, 12.

Locality: St. 4 (Bôsô Peninsula, 287 m).

Distribution: East Indies; Ryukyu, Kyushu; Shikoku and Honshu (north to Bôsô Peninsula).

226. *Macoma tokyoensis* MAKIYAMA

1865 *Tellina dissimilis* MARTENS, Ann. Mag. Nat. Hist., (3) **16**, p. 430 (*non* DESHAYES 1854).
1927 *Macoma tokyoensis* MAKIYAMA, Mem. Coll. Sci. Kyoto Imp. Univ, (B) **3** (1), p. 50.

Locality: St. 483 (off Yamaguchi Pref., 130 m).

Distribution: Kyushu; Shikoku, Honshu and Korea.

227. *Semelangulus miyatensis* (YOKOYAMA)

1920 *Tellina miyatensis* YOKOYAMA, Jour. Coll. Sci. Imp. Univ. Tokyo, **39** (6), p. 115, pl. 7, fig. 18.

Locality: St. 4 (off Bôsô Peninsula, 287 m).

Distribution: Kyushu (Ariake Bay) and Honshu.

Remarks; This genus was allocated in the family Semelidae by IREDALE in having the long lamellate lateral tooth parallel to the dorsal margin and an internal ligament, but is too close to the genera *Moerella* and *Fabulina* in shape. Therefore this genus is still retained in the Tellinidae.

228. *Moerella nishimurai* KURODA et HABE sp. nov.

Shell small, thin, elongate oval, very inequilateral. compressed, semitranslucently white to pale yellow, shining ; posterior margin shortly rostrated and the anterior side elongate, rounded at the end ; surface sculpture concentric ; postero-dorsal margin short, very oblique and the antero-dorsal margin nearly straight ; right valve with two cardinal teeth on the narrow hinge plate and a lamellate lateral tooth well developed in parallel to the dorsal margin ; no lateral tooth in the left valve.

Length 9.5 mm, height 5.7 mm, and breadth 3.0 mm (type specimen)

Length 9.2 mm, height 5.6 mm, and breadth 2.9 mm (paratype specimen)

Type locality: Funagoshi, Oga city, Akita Pref., Honshu (collected by Mr. T. NISHIMURA).

Localities: St. 4 (off Bôsô Peninsula, 287 m) ; Sts. 459 and 562 (off Tsushima, 115 m and 117 m).

Distribution: Kyushu and Honshu.

229. *Fabulina nitidula* (DUNKER)

1872 *Tellina nitidula* DUNKER, Mal. Blatt., **6**, p. 236.

Localities: St. 4 (off Bôsô Peninsula, 287 m) ; Sts. 462 (off Tsushima, 117 m) ; Sts. 483 and 488 (off Yamaguchi Pref., 130 m and 406 m) and St. 625 (off Akita Pref., 51 m).

Distribution: Formosa ; Kyushu ; Shikoku and Honshu.

230. *Fabulina soyoae* sp. nov.

Shell elongate ovate, thin, shining, orange yellow, depressed ; sculpture of fine concentric lines of growth ; beak small, situated far back ; anterior dorsal margin longer than the posterior dorsal ; anterior margin rounded and the posterior obliquely truncated ; ventral margin slightly convex.

Length 17.7 mm, height 1.00 mm and breadth 2.5 mm (left valve) (type specimen)

Type locality: St. 483 (off Yamaguchi Pref.).

Localities: St. 413 (off Ôsumi Peninsula, 249 m) and St. 483 (off Yamaguchi Pref., 130 m).

Remarks: This new species somewhat approaches to *Fabulina nitidula* (DUNKER), but may be easily distinguished from that species in having the less transversely oval shell with the highly polished surface and the more strongly rostrated hind part.

231. *Fabulina abyssicola* sp. nov.

Shell transversely ovate, polished, a little inflated, attenuated posteriorly and obliquely and narrowly truncated at the posterior end; anterior side longer than the posterior, rounded extremity; surface concentrically striated and orange yellow; left valve with two cardinal teeth on the narrow hinge.

Length 21.1 m, height 12.2 mm and breadth 3.4 mm (left valve) (type specimen)
Length 20.2 m, height 11.2 mm and breadth 2.9 mm (left valve) (paratype specimen)

Type locality: St. 220 (Tosa Bay).

Localities: St. 220 (Tosa Bay, 234 m); St. 249 (Sagami Bay, 229 m) and Sts. 433 and 439 (off Gotô Islands, 168 m and 155 m).

Distribution: Kyushu; Shikoku and Honshu (north to Sagami Bay).

Remarks: This is very characteristic in having the transversely ovate shell with the short hind rostration and the distictly striated growth lines on the surface.

232. *Bathytellina citrocarnea* KURODA et HABE gen. et sp. nov.

Shell elongate oval, thin but rather solid, moderately inflated, orange rose, especially deep in color at the flexuous postero-dorsal area. beak small, situated at the posterior third of dorsal margin; the antero-dorsal margin being longer than the postero-dorsal; the anterior margin rounded and the posterior margin slightly rostrated and weakly truncated at the extremity; the hinge plate of the right valve with two cardinal teeth, the anterior tooth of which is stronger than the posterior and bifurcate and anterior and posterior lateral teeth far from the cardinal teeth; in the left valve no lateral teeth present; mantle line with a deep posterior sinuation.

Length 19.4 mm, height 12.1 mm and breadth 6.2 mm (type specimen)
Length 18.2 mm, height 11.5 mm and breadth 5.5 mm (paratype specimen)

Type locality: Tosa Bay, Shikoku (collected by Mr. A. TERAMACHI).

Localities: St. 216 (off Kannoura, Kôchi Pref., 274 m); St. 220 (Tosa Bay, 234 m); Sts. 437 and 439 (off Gotô Islands, 307 m and 155 m) and St. 475 (off Tsushima, 192 m).

Distribution; Kyushu; Shikoku and Honshu (north to Sagami Bay).

Remarks: This new deep sea tellinid species has a different hinge armature from the genera *Fabulina* and *Moerella* despite of the close resemblance of shape. Therefore this is proposed a new generic name *Bathytellina*.

233. *Pharaonella perrieri* (BERTIN)

1878 *Tellina perrieri* BERTIN, Rev. Tellinides, p. 255, pl. 8, fig. 8.
1903 *Tellina consanguinea* SOWERBY, Ann. Mag. Nat. Hist., (7) 12, p. 500.

Locality: St. 4 (Bôsô Peninsula, 287 m).

Distribution: Kyushu, Shikoku and Honshu.

Order ADAPEDONTA

Superfamily Solenacea

Family Solenidae

234. *Solen* (*Solenarius*) *krusensterni* SCHRENCK

1867 *Solen krusensterni* SCHRENCK, Reisen Amurl. u. Nordjap., **2**, p. 594, pl. 25, figs. 9-12.

Locality: St. 274 (Suruga Bay, 51 m).

Distribution: Saghalien; Korea; Honshu; Shikoku and Kyushu.

235. *Solen* (*Solenarius*) sp.

Localities: St. 211 (off Tanabe, Wakayama Pref., 190); St. 248 (Sagami Bay, 178 m); St. 327 (off Uwajima, Ehime Pref., 216 m); Sts. 459 and 468 (off Tsushima, 115 m and 112 m) and St. 488 (off Yamaguchi Pref., 408 m).

Distribution: Kyushu; Shikoku and Honshu.

Remarks: This is *Solen luzonica* REEVE by KIRA 1954 (Illust. Shell Japan, pl. 61, fig. 1). But it is not identical with that species. All specimens collected during this survey are imperfect. Therefore it remains as an undetermined species.

236. *Solecurtus wilsoni* TRYON

1870 *Solecurtus wilsoni* TRYON, Amer. Jour. Conch., **6**, p. 23, pl. 1, fig. 2.

Localities: Sts. 249 and 276 (off Sagami Bay, 229 m and 77 m) and St. 523 (off Tottori Pref., 181 m).

Distribution: China; Kyushu and Honshu.

Superfamily Mactracea

Family Mesodesmatidae

237. *Spondervillia bisculpta* (GOULD)

(Pl. I, fig. 14)

1861 *Ervillia bisculpta* GOULD, Proc. Boston Soc. Nat. Hist., **8**, p. 23.

Locality: St. 4 (off Bôsô Peninsula, p. 287 m).

Distribution: Siam Bay; Kyushu; Shikoku and Honshu (north to Bôsô Peninsula).

Family Mactridae

238. *Mactra sulcataria* REEVE

1854 *Mactra sulcataria* REEVE, Conch. Icon., sp. 5.
1904 *Mactra carneopicta* PILSBRY, Proc. Acad. Nat. Sci. Phila., **56**, p. 550, pl. 38, figs. 1-3.

Localities: St. 4 (off Bôsô Peninsula, 287 m) and St. 210 (off Wakayama Pref., 165 m).

Distribution: China; Korea; Kyushu; Honshu; Hokkaido and Saghalien.

239. *Mactra crossei* (DUNKER)

1877 *Trigonella crossei* DUNKER, Mal. Blatt., **24**, p. 74.

Localities: St. 298 (off Toi-zaki, Miyazaki Pref., 117 m) and St. 451 (off Gotô Islands, 187 m).

Distribution: Kyushu and Honshu.

240. *Mactra iridescens* KURODA et HABE sp. nov.

Shell small, thin, white, smooth, except striated antero- and postero-dorsal areas, polished and iridescens, trigonal in shape, moderately inflated; a rather distinct keel runs from the beak to the postero-ventral corner and also an obtuse keel from the beak to the antero-ventral corner; ventral margin weakly curved.

Length 14.5 mm, height 10.5 mm and breadth 6.8 mm (type specimen)

Length 14.0 mm, height 10.7 mm and breadth 3.6 mm (right valve) (paratype specimen).

Length 17.4 mm, height 12.6 mm and breadth 3.9 mm (right valve) (specimen from St. 444).

Type locality: Off Yakushima (ex HIRASE).

Localities: St. 444 (off Gotô Islands, 194 m).

Distribution: Kyushu and Honshu (Wakayama Pref.).

Remarks: This species differs from *Mactra crossei* (DUNKER) in having the white and inflated trigonal shell with a distinct keel from the beak to the postero-ventral corner.

241. *Oxyperas bernardi* (PILSBRY)

(Pl. II, fig. 13)

1904 *Spisula bernardi* PILSBRY, Proc. Acad. Nat. Sci. Phila., **56**, p. 550, pl. 39, figs. 4–6.

Localities: St. 251 (Sagami Bay, 165 m); St. 259 (Suruga Bay, 188 m); St. 319 (off Miyazaki Pref., 210 m); St. 322 (Bungo Channel, 110 m); St. 384 (the entrance of Ise Bay, 21–38 m); Sts. 440, 444 and 445 (off Gotô Islands, 152 m, 194 m and 73 m); St. 461 (off Tsushima, 120 m); St. 470 (off Hakata Bay, Fukuoka Pref., 73 m); St. 471 (off Yamaguchi Pref., 90 m); St. 494 (off Shimane Pref., 110 m) and Sts. 519 and 521 (off Tottori Pref., 81 m and 86 m).

Distribution: Formosa; Kyushu; Shikoku and Honshu (north to Bôsô Peninsula).

242. *Lutraria sieboldi* REEVE

1854 *Lutraria sieboldtii* (*sic*) REEVE, Conch. Icon. sp. 15.
1920 *Lutraria radiata* YOKOYAMA, Jour. Coll. Sci. Imp. Univ. Tokyo, **39** (6), 110, pl. 7, fig. 11.

Localities: St. 298 (off Toi zaki, Miyazaki Pref., 117 m) ; St. 440 (off Gotô Islands, 152 m) and Sts. 520 and 521 (off Shimane Pref., 75 m and 86 m).

Distribution: Kyushu ; Shikoku and Honshu.

Superfamily Hiatellacea

Family Hiatellidae

243. *Hiatella orientalis* (YOKOYAMA)

1920 *Saxicava orientalis* YOKOYAMA, Jour. Coll. Sci. Imp. Univ. Tokyo, **39** (6), p. 106, pl. 7, figs. 2, 3.
1924 *Petricola awana* YOKOYAMA, Jour. Coll. Sci. Imp. Univ. Tokyo, **45** (1), p. 42, pl. 2, figs. 12, 13 ; pl. 3, fig. 1.

Localities: Sts. 11, 12, and 13 (off Chôshi, Chiba Pref., 375 m, 325 m and 210 m) ; St. 78 (off Shiriyazaki, Aomori Pref., 143 m) ; Sts. 205 and 207 (Kumano-nada, 224 m and 229 m) ; Sts. 210 and 211 (off Wakayama Pref., 165 m and 190 m) ; St. 200 (Tosa Bay, 234 m) ; St. 252 (Sagami Bay, 289 m) ; Sts. 276 and 279 (Suruga Bay, 77 m and 156 m) ; Sts. 301 and 304 (off Toi-zaki, Miyazaki Pref., 181 m and 241 m) ; Sts. 321 and 322 (Bungo Channel, 457 m and 110 m) ; St. 325 (off Uwajima, Ehime Pref., 210 m) ; St. 331 (off Ashizuri-zaki, Kochi, Pref., 344 m) ; Sts. 417 and 419 (off Makurazaki, Kagoshima Pref., 192 m and 402 m) ; St. 428 (off Amakusa, 119 m) ; Sts. 433, 440, 447, 452 and 475 (off Gotô Islands, 168 m, 152 m, 90 m, 154 m and 192 m) ; Sts. 462 and 468 (off Tsushima, 117 m and 112 m) ; Sts. 471, 481 and 483 (off Yamaguchi Pref., 90 m, 143 m and 130 m) ; St. 498 (off Shimane Pref., 139 m) ; St. 504 (off Oki Islands, 106 m) ; St. 575 (off Noto Peninsula, 123 m) ; St. 591 (off Niigata Pref., 311 m) ; Sts. 600, 602 and 606 (off Sado Island, 168 ; 205 m and 117 m) ; St. 627 (off Akita Pref., 148 m) and St. 637 (off Oga Peninsula, 145 m).

Distribution: Kyushu ; Shikoku ; Honshu ; Hokkaido and Korea.

Superfamily Myacea

Family Corbulidae

244. *Varicorbula bifrons* (A. ADAMS)

(Pl. II, fig. 14)

1860 *Corbula bifrons* A. ADAMS, Ann. Mag. Nat. Hist., (3) **5**, p. 412.
1922 *Corbula substriata* YOKOYAMA, Jour. Coll. Sci. Imp. Univ. Tokyo, **44**, p. 125, pl. 7, fig. 3.

Localities: St. 4 (off Bôsô Peninsula, 287 m) ; St. 11 (off Chôshi, Chiba Pref., 375 m) St. 221 (Tosa Bay, 209 m) ; St. 240 (Sagami Bay, 192 m) ; Sts. 274, 276 and

279 (Suruga Bay, 51 m, 77 m and 155 m); St. 300 (off Toi-zaki, 110 m); Sts. 319 and 322 (Bungo Channel 210 m and 110 m); St. 327 (off Uwajima, Ehime Pref., 216 m); St. 345 (off Muroto-zaki, 165–199 m); St. 363 (off Owase, Mie Pref., 439 m); St. 365 (off Hamashima, Mie Pref., 93 m); Sts. 376 and 377 (off Omae-zaki, Shizuoka Pref., 64 m and 82 m); St. 384 (the entrance of Ise Bay, 21–38 m); St. 395 (off Tanabe, Wakayama Pref., 46 m); St. 428 (off Amakusa, 119 m); Sts. 444, 447, 448, 452 (off Gotô Islands, 194 m, 90 m, 157 m and 154 m); Sts. 459, 462, 468 and 469 (off Tsushima, 115 m, 117 m, 112 m, and 91 m); St. 470 (off Hakata Bay, Fukuoka Pref., 73 m); St. 479 (off Urusan, Korea, 148 m); Sts. 484 and 488 (off Yamaguchi Pref., 93 m and 406 m); Sts. 491, 494 and 520 (off Shimane Pref., 112 m, 110 m and 75 m); St. 503 (off Oki Islands, 146 m) and St. 554 (off Ishikawa Pref., 95 m).

Distribution: Kyushu; Shikoku and Honshu (north to Bôsô Peninsula and Noto Peninsula).

245. *Varicorbula yokoyamai* HABE

1922 ***Corbula pygmaea*** YOKOYAMA, Jour. Coll. Sci. Imp. Univ. Tokyo, **44**, p. 125, pl. 7, figs. 4, 5, (*non* HANLEY 1856).

1949 ***Varicorbula yokoyamai*** HABE, Illust. Cat. Jap. Shells, **1** (1), p. 2. pl. 1, fig. 5.

Localities: St. 78 (off Shiriyazaki, Aomori Pref., 102 m) and St. 491 (off Shimane Pref., 112 m).

Distribution: Kyushu (Ariake Bay); Honshu (Tokyo Bay and two stations cited above).

246. *Anisocorbula scaphoides* (HINDS)

1843 ***Corbula scaphoides*** HINDS, Proc. Zool. Soc. London, p. 56.

Locality: St. 300 (off Toi-zaki, Miyazaki Pref., 110 m).

Distribution: Ceylon; East Indies; Philippines, China; Formosa; Kyushu; Shikoku and Honshu (north to Wakayama Pref.).

247. *Anisocorbula modesta* (REEVE)

1843 ***Corbula modesta*** REEVE, Conch., Icon., sp. 14.

Localities: St. 327 (off Uwajima, Ehime Pref., 216 m) and St. 445 (off Gotô Islands, 75 m).

Distribution: East Indies; Philippines; Kyushu; Shikoku and Honshu (north to Wakayama Pref.)

248. *Anisocorbula venusta* (GOULD)

1861 ***Corbula venusta*** GOULD, Proc. Boston Soc. Nat. Hist., **8**, p. 25.

Localities: St. 11 (off Chôshi, Chiba Pref., 375 m); St. 78 (off Shiriya-zaki, Aomori

Pref., 143 m) Sts. 240, 249 and 255 (Sagami Bay, 192 m, 229 m and 263 m); St. 259 (Suruga Bay, 188 m); St. 304 (off Toi-zaki, Miyazaki Pref., 241 m); St. 327 (off Uwajima, Ehime Pref., 216 m); St. 345 (off Muroto-zaki, 165-199 m); St. 362 (off Owase, Mie Pref., 64 m); St. 376 (off Omae-zaki Shizuoka Pref., 64 m); St. 384 (the entrance of Ise Bay, 21–38 m); Sts. 432, 433, 439, 440, 445, 447 and 452 (off Gotô Islands, 148 m, 168 m, 152 m, 73 m, 90 m and 154 m); Sts. 459, 462, 564, 468 and 469 (off Tsushima, 115 m, 117 m, 110 m, 112 m and 91 m); St. 470 (off Hakata Bay, Fukuoka Pref., 73 m); St. 477, (off Pusan, Korea, 99 m); Sts. 481, 483 and 486 (off Yamaguchi Pref., 143 m, 130 m and 139 m); St. 494 (off Shimane Pref., 110 m); St. 506 (off Oki Islands, 106 m); St. 577 (off Noto Peninsula, 311 m) and St. 646 (off Tsugaru Peninsula, 123 m).

Distribution: Kyushu; Shikoku; Honshu; southern Hokkaido and Korea.

249. *Anisocorbula minutissima* HABE

(Pl. II, fig. 15)

1949 ***Anisocorbula minutissima*** HABE, Illust. Cat. Jap. Shells, **1** (1), p. 4, pl. 1, fig. 6.

Localities: Sts. 447 and 459 (off Gotô Islands, 90 m and 115 m); St. 468 (off Tsushima, 112 m) and Sts. 484 and 486 (off Yamaguchi Pref., 93 m and 139 m).

Distribution: Kyushu; Shikoku and Honshu.

250. *Potamocorbula amurensis* (SCHRENCK)

1862 ***Corbula amurensis*** SCHRENCK, Bull. Acad. Imp. Sci. St. Petersburg **4**, p. 412.
1862 ***Corbula amplexa*** A. ADAMS, Ann. Mag. Nat. Hist., **9**, p. 233.
1922 ***Corbura frequens*** YOKOYAMA, Jour. Coll. Sci. Imp. Univ. Tokyo, **44**, p. 123, pl. 6, fig. 16, 17.
1922 ***Corbula pustulata*** YOKOYAMA, *l. c.*, p. 123, pl. 6, fig. 18.
1922 ***Corbula sematensis*** YOKOYAMA, *l. c.*, p. 124, pl. 6, fig. 19.

Localities: Sts. 363 (off Owase, Mie Pref., 439 m) and Sts. 359 and 462 (off Tsushima, 115 m and 117 m).

Distribution: Siberia; Korea; North China; Hokkaido; Honshu and Tsushima.

Remarks: Specimens from this survey are immature, but they are quite agree well with the young specimens of this species from Takahoko-numa in Aomori Pref., Honshu.

Superfamily Pholadacea

Family Pholadidae

251. *Barnea* (*Umitakea*) *japonica* (YOKOYAMA)

(Pl. I, fig. 26)

1920 ***Pholadomya japonica*** YOKOYAMA, Jour. Coll. Sci. Imp. Univ. Tokyo, **39** (6), p. 106, pl. 6, figs. 30, 31.

Locality: St. 483 (off Shimane Pref., 130 m).
Distribution: Kyushu; Shikoku and Honshu.

252. *Nettastomella japonica* (Yokoyama)

(Pl. II, fig. 11)

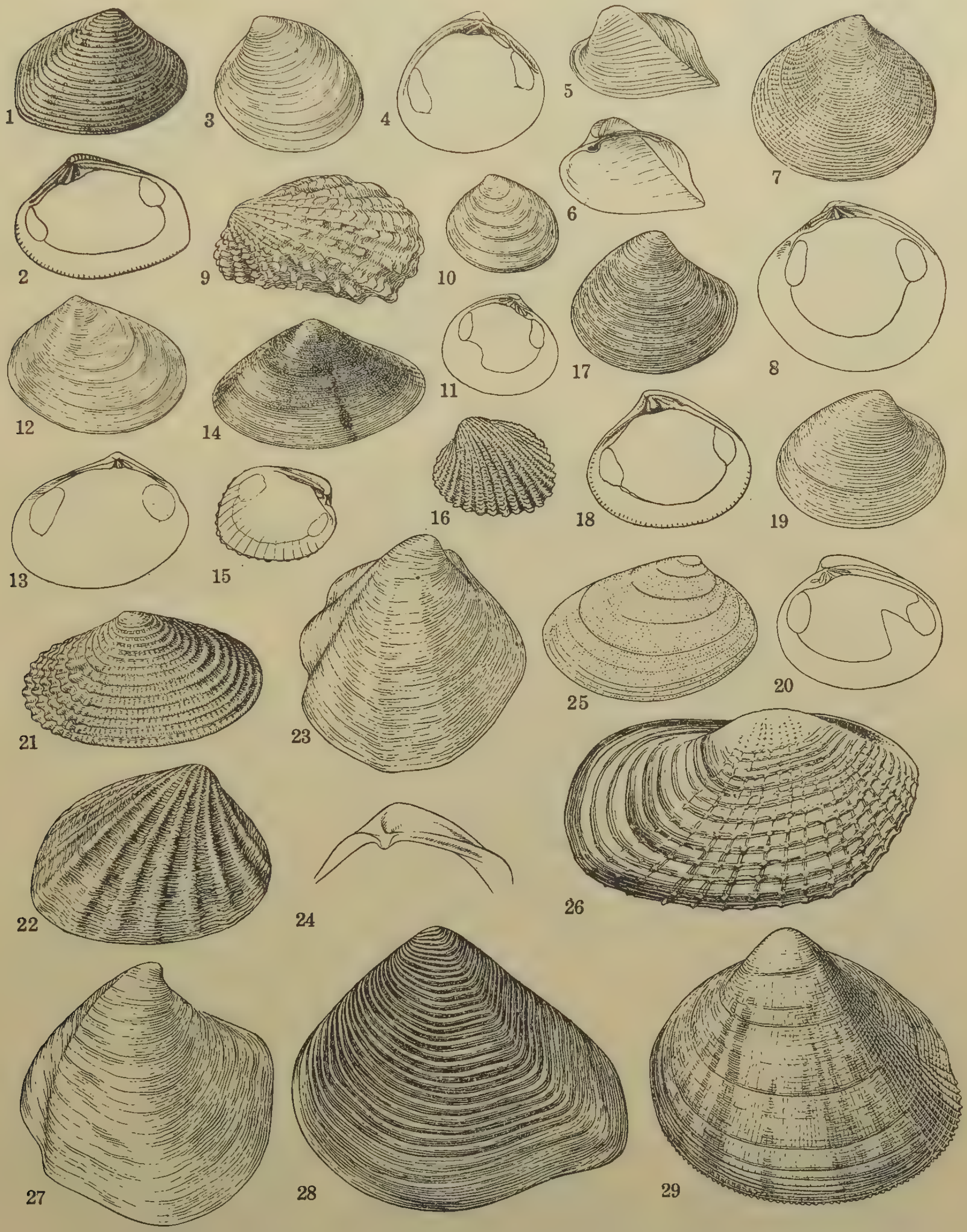
1920 *Jouannetia japonica* Yokoyama, Jour. Coll. Sci. Imp. Univ. Tokyo, **39** (6), p. 105, pl. 7, fig. 1.

Localities: St. 564 (Yamato-tai, off Noto Peninsula, 305 m) and Sts. 605 and 606 (off Sado Island, 139 m and 117 m).
Distribution: Honshu and Hokkaido.

EXPLANATION OF PLATE I

Figs. 1, 2.	*Crassatina oblongata* (Yokoyama), 10.7×8.9 mm.
Figs. 3, 4.	*Microcirce gordonis* (Yokoyama), 3.5×3.5 mm.
Figs. 5, 6.	*Meiocardia tetragona* (A. Adams et Reeve), 29.1×18.6 mm.
Figs. 7, 8.	*Circe* (*Redicirce*) *nana* Melvill, 12.6×11.5 mm.
Fig. 9.	*Cardita nodulosa* Lamarck, 18.7×11.7 mm.
Figs. 10, 11.	*Laevicirce soyoae* Habe, 6.7×6.2 mm.
Figs. 12, 13.	*Abra soyoae* Habe (sp. nov.), 12.2×9.2 mm.
Fig. 14.	*Spodervillia bisculpta* (Gould), 5.2×3.5 mm.
Figs. 15, 16.	*Glans hirasei* (Dall), 21.1×17.4 mm.
Figs. 17, 18.	*Astarte hakodatensis* Yokoyama, 9.7×9.3 mm.
Figs. 19, 20.	*Pitar* (*Costellipitar*) *chordatum* (Roemer), 10.0×9.0 mm.
Fig. 21.	*Elliptotellina fabrefacta* (Pilsbry), 7.3×4.4 mm.
Fig. 22.	*Venericardia* (*Megacardita*) *ferruginosa* (A. Adams et Reeve), 20.3×17.2 mm.
Figs. 23, 24.	*Thyasira* (*Philis*) *kanamarui* Habe, 9.0×8.0 mm.
Fig. 25.	*Cadella lubrica* (Gould), 14.6×9.5 mm.
Fig. 26.	*Barnea* (*Umitakea*) *japonica* (Yokoyama), 66.6×39.6 mm.
Fig. 27.	*Thyasira* (*Parathyasira*) *kawamurai* Habe, 12.5×12.1 mm.
Fig. 28.	*Crassatellites nanus* (A. Adams et Reeve) 41.7×36.5 mm.
Fig. 29.	*Keenaea samarangae* (Makiyama), 28.7×26.4 mm.

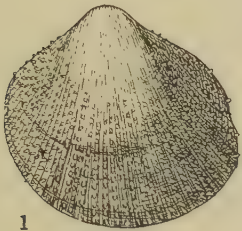
PLATE I



T. Habe: Mollusca Chiefly Collected by the Sôyô-maru, 4.

EXPLANATION OF PLATE II

Fig. 1.	*Frigidocardium eos* (Kuroda), 20.7×19.6 mm.
Fig. 2.	*Divalucina soyoae* (Habe), 28.5×27.0 mm.
Fig. 3.	*Bellucina civica* (Yokoyama), 7.7×7.8 mm.
Fig. 4.	*Axinopsida subquadrata* (A. Adams), 3.8×3.7 mm.
Fig. 5.	*Conchocele disjuncta* Gabb, 25.9×23.0 mm.
Fig. 6.	*Lajonkairia divaricata* (Lischke), 15.8×14.4 mm.
Fig. 7.	*Placamen tiara* (Dillwyn), 15.2×13.0 mm.
Fig. 8.	*Venus (Ventricolaria) toreuma* Gould, 25.7×23.4 mm.
Fig. 9.	*Liocyma aniwana* Dall, 34.8×21.7 mm.
Fig. 10.	*Notomyrtea soyoae* Habe, 6.6×5.9 mm.
Fig. 11.	*Nettastomella japonica* (Yokoyama), 13.9×10.0 mm.
Fig. 12.	*Callanaitis hiraseana* Kuroda, 17.0×12.7 mm.
Fig. 13.	*Oxyperas bernardi* (Pilsbry), 62.3×34.6 mm.
Fig. 14.	*Varicorbula bifrons* (A. Adams), 4.8×4.2 mm.
Fig. 15.	*Anisocorbula minutissima* Habe, 5.2×3.8 mm.
Figs. 16, 17.	*Alucinoma soyoae* Habe, 10.7×10.4 mm.
Fig. 18.	*Trifaricardium nomurai* Kuroda et Habe, 15.5×15.5 mm.
Fig. 19.	*Astarte (Tridonta) multicostata* Filatova, 25.1×20.3 mm.
Fig. 20.	*Venus (Ventricoloides) foveolata* Sowerby, 48.5×42.1 mm.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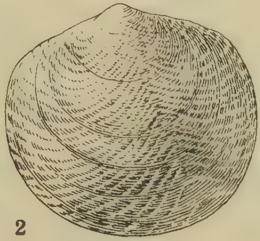
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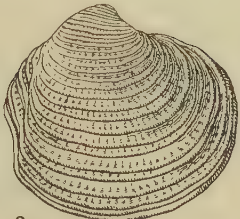
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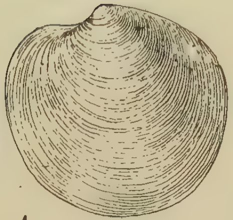
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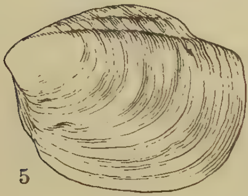
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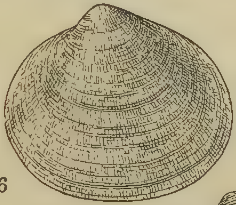
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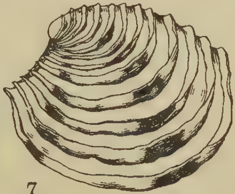
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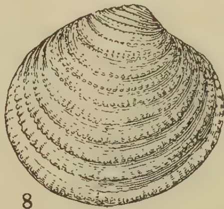
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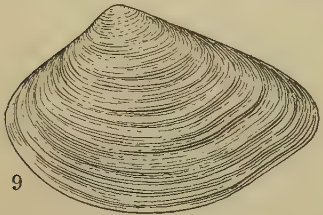
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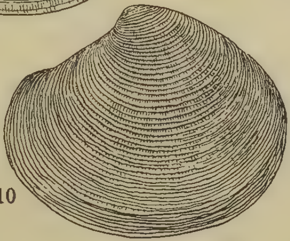
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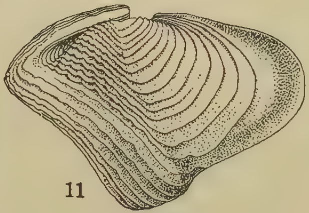
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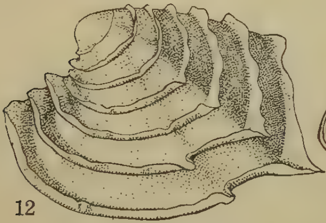
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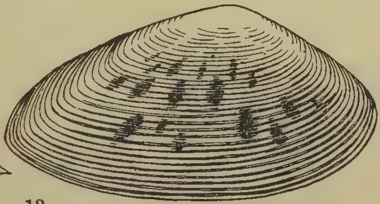
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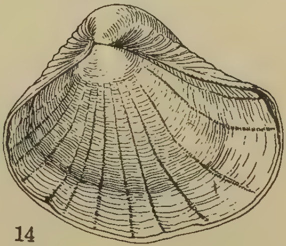
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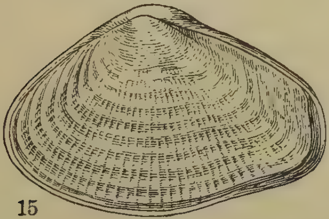
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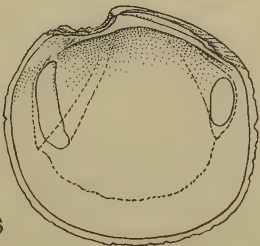
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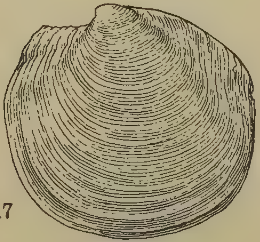
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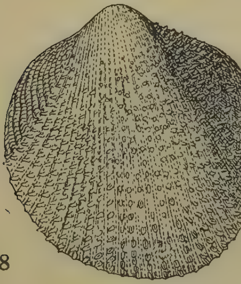
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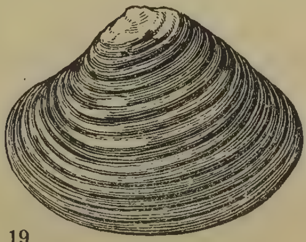
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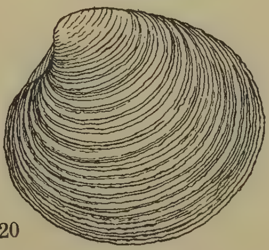
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T. HABE: MOLLUSCA CHIEFLY COLLECTED BY THE SÔYÔ-MARU, 4.

STUDIES ON THE HELMINTH FAUNA OF JAPAN

PART 53. TREMATODES OF FISHES, XII

SATYU YAMAGUTI

Department of Parasitology, Okayama University
Medical School, Okayama

With Plates III–IV

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MONOPISTHOCOTYLEA ODHNER, 1912

Capsaloidea PRICE, 1936

Capsalidae BAIRD, 1853

1. *Benedeniella congeri* n. g., n. sp.

(Pl. III, Fig. 4)

Habitat: Gills of *Conger myriaster* BREVOORT.
Material: A single mature specimen.
Locality and date: Inland Sea; September 11, 1957.

Body, including opisthohaptor, measuring 1.2 mm in length, with maximum width of 0.46 mm at about middle of body proper which is nearly elliptical in outline. Prohaptor prominent, sucker-like, with circular pit at center, oval in outline, 0.14 × 0.15 mm, connected with each other by concave membrane anterodorsally and separated ventrally by a distance of 80μ. Opisthohaptor circular, about 0.35 mm anteroposteriorly, with narrow, frilled, marginal membrane, a number of marginal hooklets 8μ long, and three pairs of anchors; anterior anchor rod-shaped, 85μ long by 15μ wide, blunt-pointed at its free anterior end and terminating in two unequal tips; middle and posterior anchors slender, with ventrally curved sharp point, former 85μ long, latter about 39μ long. The anterior circular muscle fibers are converged toward the base of the middle anchor; radial muscles are well developed around the center, where the haptor is attached to the body proper; the oblique muscle bundles arising from the lateral portions of the body proper cross one another soon after entering the haptor and are split into individual fibers as they approach the anterior anchor; the bases of the anterior anchors are connected by transverse muscle bands, of which the anteriormost is the strongest; dorsoventral muscle bundles are well developed throughout the haptor except for the central and marginal areas.

Mouth oval, opening immediately behind two pairs of eye-spots; pharynx 0.1 × 0.14 mm, with a notch on each side and posterodorsally. Ceca with numerous, simple or branched, outer branches, terminating close to each other near posterior extremity of body proper; anteriormost branches approaching each other immediately in front of eye-spots.

Testes oval, pressed one against the other, just postequatorial, 0.25 × 0.15 mm.

The vas deferens forming a transverse loop between the proximal transverse portion of the germiduct and the seminal receptacle passes along the left side of the seminal receptacle and after crossing the proximal end of the vagina dorsally runs forward and then turning to the right across the dorsal side of the ootype forms another loop dorsal to the prostatic reservoir before leading into the seminal vesicle enclosed in the cirrus pouch. The cirrus pouch, approximately claviform and 0.18 mm long, has a thick wall of circular muscle fibers and a maximum width of 62μ at the level of the swollen internal seminal vesicle. It contains a fusiform seminal vesicle continued into the narrow ejaculatory duct lined with thick smooth cuticle, and a club-shaped prostatic bulb provided with a thick wall of diagonal muscle fibers. The latter bulb is 0.17 mm long by 36μ wide and contains a column of spermatozoa in the center, and has a clear space between this column and its inner wall apparently devoid of epithial lining. Prostatic reservoir oval, 65μ long by 46μ wide, completely filled with spermatozoa instead of the prostatic secretion, which appears to be confined to the conical distal end of the reservoir, surrounding the central column of spermatozoa; the prostatic cells lie on the right of the reservoir, partly scattered among the vitelline cells, with their ducts converged toward the base of the reservoir. The cirrus pouch and the prostatic reservoir are enclosed in a thin-walled sac, which functions as genital atrium as it joins the uterus. The distal end of the ejaculatory duct projects into the slightly dilated prostatic duct near the distal end of the cirrus pouch and then opens at the tip of the cirrus pouch into the genital atrium which in turn immediately opens outside ventrally close to the body margin behind the left haptoral sucker.

Ovary ovoid, 0.1×0.11 mm, situated medianly immediately in front of two testes; the germiduct running from the left to the right along the anterior border of the ovary joins the seminal duct coming obliquely backward from the seminal receptacle, and turning back on itself anterodextral to the ovary leads into the uterus. The narrow proximal portion of the uterus lined with epithelia is tubular and surrounded by shell gland cells. The uterus proper is ovoid, 52μ by 36μ, and opens into the genital atrium by a very short narrow duct lined with cuticle. The whole uterus is enclosed in a subcylindrical membranous sac, which in turn is sourrounded by a dense coat of glandular cells except at the two extremities. No eggs observed. Vagina well chitinized, subcylindrical, 26μ long by 14μ wide, opening slightly dorsally on left margin of body at level of pharynx; vaginal duct long and simple for greater distal portion but twisted proximally; seminal receptacle 39×31μ, filled with spermatozoa, situated anterosinistral to ovary, seminal duct about 30μ long by 7.5μ wide. Vitellaria surrounding whole intestine and its branches, confluent across median line in front of eye-spots as well as in posttesticular area. Paired excretory vesicles opening dorsally at level of prostatic reservoir.

The present genus is distinguished from the related known genera of Benedeniinae in the cirrus pouch containing the seminal vesicle and a strongly differentiated prostatic duct, and being enclosed *in toto* in the genital atrium. Further, the presence of a seminal receptacle filled with spermatozoa in place of the vitelline reservoir and that the whole uterus is enclosed in a membranous sac are worth noting.

Benedeniella n. g.

Generic diagnosis. Capsalidae, Benedeniinae: Oculate. Prohaptor sucker-like, not enclosed in membranous hood. Opisthohaptor with marginal hooklets and marginal membrane; of the three pairs of anchors the anterior is wedge-shaped and bifid at the posterior end, each of the middle and posterior pairs has a sharp recurved point. Pharynx indented, ceca with outer branches, not united posteriorly. Testes juxtaposed. Vas deferens strongly winding, seminal vesicle enclosed in cirrus pouch along with strongly muscular prostatic bulb; ductus ejaculatorius joining distal end of prostatic bulb and opening into genital atrium. Cirrus pouch and prostatic reservoir enclosed in a thin-walled sac, into which the uterus opens from behind near the base of the cirrus pouch. Genital pore opening ventrosubmarginally immediately behind left prohaptor. Ovary median, pretesticular. Uterus enclosed in membranous sac which is surrounded by gland cells. Eggs? Vagina subcylindrical, well chitinized, opening dorsomarginally well apart from genital pore. Vitellaria co-extensive with intestine and its branches, confluent anterior to eyespots and posterior to testes; vitelline reservoir? Parasitic on gills of marine teleosts.

Genotype: *B. congeri* n. sp.

2. *Metabenedeniella hoplognathi* n. g., n. sp.

(Pl. III, Fig. 5)

Habitat: Gill of *Hoplognathus fasciata* and *Epinephelus septemfasciatus.*

Material: 22 mature specimens from first type host and two more from second host, fixed under cover glass pressure, stained and mounted *in toto.*

Locality and date: Suma Municipal Aquarium; April 9, 1958.

Body 1.5–2.2 mm in length inclusive of opisthohaptor, 0.75–1.05 mm in maximum breadth about middle of body proper, which is almost elliptical in outline. Prohaptor prominent, shaped like an oval saucer, 0.25–0.36×0.17–0.23 mm, with membranous border glandular in structure, showing dark-staining granules which are condensed in the equatorial zone, diminishing toward the anterior margin. The posterior part of the haptor devoid of dark granules is provided with fine muscle fibers which are perpendicular to the surface. The paired prohaptors are separated ventrally in the type 2.2 mm long by a distance of 26μ; they are connected anterodorsally by a plane or concave membrane, and there is no overhanging hood-like formation.

Opisthohaptor circular, 0.6–0.75 mm in diameter including the marginal membrane, well provided with dorsoventral, radial and circular muscle fibers, of which some of the central radial fibers appear to be continued into the powerful longitudinal muscle bundles of the body proper. The marginal membrane divided into large numbers of lobes whose free outer margin is broadly rounded and may or may not be subdivided into three to five lobules. No marginal hooklets have been detected in contrast with *Benedeniella.* The three pairs of anchors are similar to those of *Benedeniella congeri* described above, measuring 93–120μ, 65–83μ and 60–86μ in respective length.

Two pairs of eye spots situated anterodorsal to pharynx. Mouth oval, opening between eye spots of posterior pair. Pharynx 0.14 0.19 × 0.15–0.27 mm, with a distinct notch on each side. Esophagus practically absent; ceca transverse at very beginning, with a dense, transversely elongated mass of pharyngeal gland cells immediately behind; their first two branches are directed forward and encircling the pharynx approach each other in the median line anterior to the eye spots; after giving off a few short inner branches and a number of terminally bifurcate outer branches almost reaching the lateral edge of the body, the ceca terminate at the level of the anterior end of the opisthohaptor.

Testes oval, juxtaposed at junction of middle with posterior third of body proper with their long axes widely divergent, occupying whole intercecal width, 0.12–0.3 × 0.09–022 mm. The vas deferens ascending along the sinistrodorsal side of the ovary turns to the right and after crossing the seminal receptacle dorsally turns back on itself to proceed in a serpentine course on the left of the uterus and then across it dorsally; finally it runs backward dorsal to the cirrus pouch, at the posterior end of which it turns back on itself to be continued into the ejaculatory duct. All the way through there is no dilatation of the duct in form of a seminal vesicle. The tubular cirrus pouch is 0.9–1.2 mm long and 0.04–0.07 mm wide at its somewhat swollen base, and follows a long serpentine course from the left marginal genital pore, past behind the intestinal bifurcation and medial to the right cecum, to the interspace between the ovary and the testes, and is enclosed throughout together with the prostatic bulb and the prostatic reservoir in a thin-walled capsule of longitudinal muscle, the distal portion of which, after it has joined the uterus, functions as a genital atrium as in *Benedeniella congeri*. Its wall consists of longitudinal muscle fibers in the distal portion down to the point where it turns backward to take the descending course from the postbifurcal transverse course, but to the remaining proximal portion is added a conspicuous outer layer of circular fibers, which increases in thickness as it proceeds backward. The ejaculatory duct, lined with thick cuticle and surrounded by circular muscle fibers, runs forward in the cirrus pouch along with the prostatic duct, but joins the latter probably near the point where the outer circular muscle layer of the cirrus pouch disappears; at this point of junction the outer circular muscle coat of the ejaculatory duct also disappears and the duct gives way to a long slender cirrus, which when everted, may attain a length of 0.27 mm, and may be thust into either the genital atrium or the vaginal pore. A bean-shaped prostatic reservoir, 0.12–0.23 × 0.06–0.11 mm, and filled with fine prostatic granules, lies between the ovary and the left cecum, with its long axis parallel or somewhat oblique to that of the body; from its wider end arises a narrow duct which opens into the prostatic bulb by way of a small sphincter-like muscular swelling (20μ in diameter in the type). The prostatic bulb containing a central column of prostatic secretion, is nearly fusiform, 0.12–0.2 mm long by 0.065–0.08 mm wide and lies obliquely between the ovary and the left testis, with its tapering distal end thrust into the base of the cirrus pouch and continued into the prostatic duct enclosed in the cirrus pouch; its extremely thick wall consists exclusively of fine oblique muscle fibers. Both the prostatic reservoir and the prostatic bulb are enclosed in the expanded basal portion of the capsule containing the cirrus pouch. The prostatic duct containing a continuous string of prostatic secretion is uniformly narrow; its thin wall consists of longitudinal muscle fibers alone. The genital atrium opens ventrally close to the anterolateral margin of the body beneath the left prohaptor.

Ovary rounded, 0.13–0.2 mm in diameter, situated in middle third of body proper, a little to right of median line. The germiduct, arising from the dorsal side of the ovary, first joins the duct coming from the vitelline reservoir and turns forward immediately anterodextral to the ovary and receives the narrow duct from the seminal receptacle. The ootype and the somewhat winding uterine duct are surrounded by shell gland cells which extend profusely in the area between the cirrus pouch and the vagina. In the expanded uterus proper lined with conspicuous epithelia is found in one specimen or two a single brown oval egg 91–104μ in diameter and provided at one pole with a recurved process about 85μ long. The uterus proper opens into the genital atrium posterolateral to the pharynx just behind the intestinal bifurcation. Vitellaria co-extensive with intestine and its branches, confluent in front of eye-spot as well as in posttesticular area; vitelline reservoir 0.05–0.14 mm anteroposteriorly, situated transversely immediately in front of ovary, receiving a collecting vitelline duct at each outer end; the vitelline duct joining the germiduct is given off from the dorsal side of the vitelline reservoir. Vagina tubular, 0.36–0.55 mm long by 0.03–0.05 mm wide, lined with cuticle and provided with muscular coat of inner longitudinal and outer circular fibers, running obliquely forward across left cecum dorsally and opening slightly dorsally on left margin of body at level of pharynx. Seminal receptacle spherical, 30–60μ in diameter, immediately in front of vitelline reservoir, connected with vagina by a short, narrow, somewhat winding duct, and with the germiduct by a straight narrow duct.

This genus differs from the most closely related *Benedeniella* essentially in the cirrus pouch being extremely long and extending into the space between the ovary and the right testis, in the cirrus being very long and eversible, in the prostatic bulb lying outside the cirrus pouch between the ovary and the left testis, and in the prostatic reservoir being shifted to the left of the ovary. The prohaptors are sucker-like in *Benedeniella*, but saucer-like and more glandular in the present genus. That the vitelline reservoir is well developed in the front of the ovary, that the uterus is not enclosed in a membranous sac and that the vagina proper is a very long muscular organ in connection with the long eversible cirrus are also important characters differentiating the present genus from *Benedeniella*.

Metabenedeniella n. g.

Generic diagnosis.—Capsalidae, Benedeniinae: Oculate. Prohaptor saucer-like, glandular. Opisthohaptor with festooned or frilled marginal membrane, without marginal hooklets; of the three pairs of anchors the anterior is wedge-shaped and bifid at the posterior end while the other pairs are hook-shaped. Pharynx indented, with pharyngeal gland cells behind intestinal bifurcation. Ceca with numerous, Y-shaped, side branches, not united posteriorly. Testes juxtaposed, postequatorial. Vas deferens winding forward, and then backward dorsal to cirrus pouch, at the base of which it passes into the ejaculatory duct. Latter well provided outside with circular muscle fibers, enclosed in cirrus pouch along with prostatic duct, with which it eventually unites to form a long eversible cirrus. Prostatic reservoir between ovary and left cecum; prostatic bulb fusiform, with extremely thick wall of oblique muscle fibers, situated between ovary and left testis, with its distal end thrust into base of cirrus pouch and continued into narrow prostatic duct which runs in the cirrus pouch along with the ejaculatory duct. Cirrus pouch unusually long, tubular, extending a long way from genital pore to behind ovary, enclosing ejaculatory duct, prostatic duct and eversible cirrus; its wall consists of inner longitudinal and outer circular muscle fibers for the greater proximal portion but lacks the circular muscle fibers for the distal portion containing the eversible cirrus alone. Cirrus pouch, prostatic bulb and prostatic vesicle are enclosed in a thin-walled common sac, the distal portion of which functions as genital atrium. Latter opening ventrally close to left margin of body beneath left prohaptor. Ovary spherical, a little to right of median line in middle third of body proper. Uterus surrounded by shell gland cells but not enclosed in membranous sac in contrast with that of *Benedeniella*; eggs with short hook-like polar process. Vagina long, tubular, muscular, opening dorsomarginally well apart from genital pore. Vitellaria coextensive with intestine and its branches; vitelline reservoir well developed immediately in front of ovary. Parasitic on gills of marine fishes.

Genotype: *M. hoplognathi* n. sp.

Microbothriidae PRICE, 1936

3. *Pseudomicrobothrium spari* n. g., n. sp.

(Pl. III, Fig. 7)

Habitat: Gills of *Sparus macrocephalus* (BASILEVSKY).

Material: Some 20 mature specimens fixed in Schaudinn's solution and stained with Heidenhain's hematoxylin.

Locality and date: Sagami Bay; June 6, 1958.

Body 1.4–2.1 × 0.6–1.1 mm, swollen in greater middle region, narrowed abruptly at level of commencement of vitellaria into a trapezoidal forebody, and produced backward into a short cylindrical haptoral stalk, at the end of which is set a circular, saucer-shaped, opisthohaptor 0.3–0.6 mm in diameter, with somewhat festooned, nonmuscular border. Cuticle thin and smooth. At the anterior extremity there is a distinct median notch, and on either side of it is a pair of ventroterminal non-muscular pseudosuckers, the inside transverse diameter of which is 0.08–0.13 mm, and the indented border of which stains deeply owing to presence of closely massed adhesive gland ducts. In the neck region behind these pseudosuckers there are two pairs of dorsal eye spots and a ventral mouth, which is immediately followed by globular pharynx 0.1–0.16 mm in diameter. In the neck and shoulder region there are numerous unicellular adhesive gland cells, whose ducts open along the margin of the pseudosuckers. The esophagus is practically lacking; the intestine consists of symmetrical limbs with few outer diverticula, each of which is strongly dilated terminally among the vitelline follicles, the last one reaching the base of the haptoral stalk.

Testis round, with irregular indentations, 0.26–0.45×0.25–0.52 mm, median, equatorial. Vas deferens arising from midde of anterior margin of testis, running forward along left margin of ovary. Seminal vesicle pyriform, 18μ wide in the type, situated at base of cirrus, with which it is connected by a short narrow duct. In front of the seminal vesicle there are two small elongate tubular prostatic reservoirs each containing fine and coarse granular secretion. Cirrus a long tubule, 0.56–0.6 mm long by 13–15μ wide, enclosed in a membranous sheath, forming a transverse loop on right of median line behind pharynx, with its curved point alongside three terminal hooks of accessory piece at genital pore. Accessory piece heavily chitinized, 0.15–0.16 mm long, consisting of prismatic main portion and three hook-shaped terminal prongs which are close together along with the distal end of the cirrus, their curved tips may or may not project out of the genital pore. Genital pore immediately postbifurcal, median, at about level of base of cirrus.

Ovary subglobular to oval, 0.11–0.14×0.14–0.22 mm, situated immediately in front of testis slightly to right of median line. The germiduct, arising from the ventral surface of the ovary, unites with the vaginal seminal receptacle near its own origin and soon joins the vitelline duct; ootype ventral to left portion of ovary; uterus ventrolateral to vas deferens, no eggs observed. Vitelline follicles comparatively large, distributed in lateral fields of swollen portion of body, approaching median line behind testis; in surface view both dorsally and ventrally they appear as if they were neatly paved, but in some specimens the follicles are dissociated ventrally so as to show the distended cecal diverticula lying underneath. Vitelline ducts dendritic, ventral to vitelline follicles; final paired ducts meeting together ventral to posterior end of ovary. There is a slit-like vaginal apperture on the ventral surface near the right body margin at a preovarian level; the vaginal duct proceeds from this pore obliquely backward toward the ovary, at the right end of which it forms a seminal receptacle, which extends transversely on the ventral surface of the right posterior portion of the ovary. Excretory system not made out.

This genus resembles *Microbothrium* OLSSON, 1869, in general anatomy, but differs from it in possessing two open bothria-like anterior pseudosuckers and simple, not dendritic, cecal branches, and in lacking a cirrus pouch.

Pseudomicrobothrium n. g.

Generic diagnosis.—Microbothriidae, Microbothriinae. Body swollen in middle region. Prohaptor in form of paired, non-muscular, bothria-like pseudosuckers which open widely anteroterminally. Opistohaptor a non-muscular, saucer-shaped organ at posterior extremity. Two pairs of eye spots present; pharynx well developed. Intestinal crura with unbranched lateral diverticula, terminating behind testis. Testes single, equatorial. Seminal vesicle and prostatic reservoirs present. No cirrus pouch. Copulatory apparatus consisting of a very long, simple, sheathed cirrus and an accessory piece. Genital pore median, postbifurcal. Ovary slightly submedian, immediately pretesticular, with shell gland complex on its ventral side, uterus short, eggs? Vagina single, dextral, opening at a preovarian level; receptaculum seminis vaginae present. Vitellaria extending in lateral fields from level of genital pore to cecal ends. Parasitic on gills of marine teleosts.

Genotype: *P. spari* n. sp.

Udonellidae TASCHENBERG, 1879

4. *Udonella caligorum* JOHNSTON, 1835

(Pl. III, Fig. 1)

A number of mature and gravid specimens were found attached on the dorsal surface of the carapace of an argulid parasitic on *Spheroides rubripes* in the Aquarium of Tokyo University at Shinmaiko.

Since this species has been inadequately described and figured by previous authors I deem it necessary to redescribe it in detail on the basis of my own specimens which were fixed in Schaudinn's solution under cover glass pressure and stained with iron-hematoxylin.

Body flat, subcylindrical or somewhat fusiform, 1.6–2.35 mm in length inclusive of opisthohaptor, 0.4–0.56 mm in maximum breadth at utero-ovarian level. Cuticle finely striated transversely; when contracted the attenuated neck or the prehaptoral region may show distinct annular corrugations. Opisthohaptor saucer-shaped, 0.2 – 0.35 mm in transverse diameter, with well developed muscles radiating from the shallow central pit, entirely devoid of chitinous holdfast apparatus. The elongate unicellular adhesive glands containing fine secretory granules are seen on each side of the body immediately behind the posteriormost vitellaria; their collecting ducts are strongly winding and join together in the median line behind the cecal end; the common duct wider than each collecting duct is also winding and proceeds toward the center of the opisthohaptor, where it opens outside. Paired anterior pseudosuckers oval in outline, 65 – 90μ long, with ducts of cervical glands openings on the surface. The rounded to pyriform cervical gland masses consisting of variable number of cells according to their size extend on each side of the body from the level of the pharynx to that of the anterior end of the ovary. On the frontal margin between the two pseudosuckers there is a pair of prominent conical sensory papillae. The mouth opening is subterminal, but when the pharynx is protruded, the oral margin is seen surmounting the pharynx in form of a belt-like hood, whose anterior free margin is very finely denticled. Pharynx subglobular to rounded quadriangular, 0.14–0.2 × 0.14–0.23 mm, provided along its wide anterior opening with a crown of about 20 conical processes. No esophagus. Intestine a simple tubular sac running backward in dorsal median field to near opisthohaptor.

Testis nearly equatorial, oval to spherical, 0.14–0.23 × 0.2–0.3 mm. Vas deferens narrow, running forward dorsal to ovary and uterus; seminal vesicle oval to elliptical or pyriform, 25–40μ wide, situated alongside prostatic reservoir a little behind pharynx, opening into genital atrium by a short narrow duct; cirrus not differentiated. Genital atrium opening midventrally a little behind pharynx. A pyriform prostatic reservoir, 28μ in diameter and containing dark-staining homogeneous secretion, lies along the seminal vesicle, with a compact mass of prostatic cells immediately behind; its distal end tapers to a short narrow duct which opens into the genital atrium along with the duct from the seminal vesicle.

Ovary globular to oval, 0.15–0.31×0.2–0.4 mm, situated immediately in front of testis. The germiduct arising from the ventral side of the ovary near its right end proceeds forward and soon joins the common vitelline duct at the anterodextral end of the ovary; the uterine duct proceeds obliquely forward from this junction and then straight forward to receive the ducts from two diffrent groups of shell glands at a short interval; the proximal group is smaller than the distal, and apparently secretes non-granular secretion. After receiving the proximal shell gland ducts from both sides the uterine duct narrows to a short straight duct and then widens abruptly as it receives the ducts of the distal group which contains very fine secretory granules. The uterus proper is a simple, wide, muscular tube, but when gravid its middle portion widens to an elliptical sac which is distended with a large elliptical egg 190–220μ long by 90–120μ wide. The long winding polar filament of the egg lies in the portion proximal to this saccular portion, with its terminal dilatation in the initial ootype into which the distal shell gland ducts open. The terminal portion of the uterus remains tubular even when gravid and opens directly into the genital atrium. Vitellaria divided into numerous large follicles, extending in each lateral field from level of genital pore to near posterior end of intestinal cecum, partly surrounding cecum both dorsally and ventrally; the paired transverse vitelline ducts crossing the ovary on its ventral surface join together near the origin of the germiduct and forms a short, forwardly directed, common duct.

The large excretory pores lie symmetrically on the lateral margins of the body at a preovarian level; the excretory stem is very short and divides into two (an ascending and a descending) collecting vessels running along the side of the body.

In the explanation of her original drawing (Fig. 38) of *Udonella caligorum* SPROSTON (1946) states that a receptaculum seminis lies below the ovary and leads to the fertilization canal which receives the two vitelline ducts, but I was unable to detect such a seminal receptacle behind the ovary. With regard to the structure of the terminal genitalia she does not give any explanation, though the prostatic complex is obscurely shown in Figs *a* and *c*. The genital pore is definitely midventral.

Gyrodactyloidea JOHNSTON et TIEGS, 1922

Dactylogyridae BYCHOWOKY, 1933

5. *Microncotrema lateolabracis* n. g., n. sp.

(Pl. IV, Fig. 11)

Habitat: Gills of *Lateolabrax japonicus* TEMM. et SCHLEG.
Material: 16 mature whole mounts, most of which had been more or less macerated.
Locality and date: Inland Sea of Japan; May 1 and September 8, 1957.

Body flattened fusiform, with anterior extremity 4-lobed and posterior extremity truncated, 0.9–1.0 mm long by 0.25–0.3 mm broad, except for those macerated specimens which are up to 2.6 mm long. The flattened type is about 2 mm in length with maximum width of about 0.8 mm at level of testis. Anterior extremity with more or less pronounced median incision in unflattened specimens, with a head organ for each of four lobes and two more between two lobes on the same side. Two pairs of dorsal eye spots at level of mouth aperture, which opens immediately in front of the pharynx. Pharynx 60-90μ in diameter, divided into a strongly muscular anterior portion and a less muscular posterior portion. Esophagus short; ceca wide, terminating blindly at about junction of middle with posterior third of body. Opisthohaptor discoid, slightly constricted off from body proper, 0.12–0.15 mm in transverse diameter (up to 0.3 mm when flattened) with only one pair of very small median anchors supported by a transverse bar, and 14 simple marginal spiness 44-47μ long; haptoral hook measuring about 15μ from base to height of curve, with its point directed dorsad; central bar only slightly curved, about 15μ long. Unicellular cement glands well developed, extending forward in longitudinal series in posttesticular intercecal field; enlarged cement cells or reservoirs occupy most of postcecal area down to haptoral apparatus. The dorsal, lateral and ventral muscle bundles originating from the bases of the marginal spines and median haptoral hooks respectively are strongly developed, especially those which pass along each side of the testis and ovary and are finally divided into individual fibers to be attached to the pharynx.

Testes rounded, 0.1–0.13×0.07–0.12 mm in unflattened specimens, 0.2×0.26 mm in the flattened type, nearly equatorial; vas deferens running forward ventral to ovary near its left border, curving round left cecum in a half-spiral from dorsal to ventral side, turning backward on the left of copulatory apparatus to form a small seminal vesicle, whose attenuated posterior end turns forward to lead into the cirrus at its base. Chitinous copulatory apparatus consisting of a broad-based, slender cirrus 83–88μ long and terminating in a spoon-shaped expansion, and a likewise slender accessory piece of neary equal length with a hook-like recurved tip. There are two prostatic complexes; the larger, anterior, longitudinal reservoir overlapping the seminal vesicle drains the anterior group of the prostatic cells, while the smaller, tubular, sigmoid duct lying transversely near the base of the copulatory appratus drains the posterior group of the prostatic cells. Genital pore at or behind intestinal bifurcation; when the body is contracted, the cirrus and its accessory piece may project out of this pore.

Ovary oval, 0.09–0.1 mm long by 0.07–0.09 mm broad (0.21 mm broad in the type), immediately pretesticular. Ootype well developed ventrally between transverse vitelline duct and seminal vesicle; egg, one at a time, oval, without polar filaments; Vitellaria extending along entire length of ceca, not confluent posteriorly; transverse vitelline duct preovarian. Vagina opening dorsally in right submedian line at preovarian level, where the right body margin is distinctly notched; it consists of a bulbous terminal swelling lined with extremely thick cuticle and surrounded by circular muscle fibers, and a cylindrical portion provided with longitudinal and circular muscles; vaginal duct tubular, thin-walled. Along the entire length of the vaginal duct run longitudinal muscle fibers in form of a sheath. Receptaculum seminis vaginae ventral to origin of germiduct.

The possession of a pair of unusually small haptoral anchors which are much smaller than the marginal spines is the most outstanding character of this genus, to which the generic name refers.

Microncotrema n. g.

Generic diagnosis.—Dactylogyridae, Dactylogyrinae: Body flattened fusiform, oculate. Opisthohaptor discoid, slightly constricted off from body proper, with one pair of very minute anchors and 14 much larger marginal spines. Pharynx muscular. Ceca terminating blindly some distance short of posterior extremity. Testis median, equatorial; vas deferens looped around left cecum; seminal vesicle developed by dilatation of terminal portion of vas deferens. Two sets of prostatic complexes present. Cirrus with accessory piece. Genital pore immediately postbifurcal. Ovary immediately pretesticular; shell gland preovarian; eggs oval, without polar filament. Vagina opening dorsal or medial to right cecum in front of ovary, receptaculum seminis vaginae present. Vitellaria surrounding ceca throughout their length. Parasitic on gills of marine teleosts.

Genotype: *M. lateolabracis* n. sp.

6. *Pseudorhabdosynochs epinepheli* n. g., n. sp.

(Pl. IV, Fig. 18)

Habitat: Gills of *Epinephelus akaara* (TEMM. et SCHLEG.).
Material: Two mature specimens.
Locality and date: Inland Sea; September 8, 1957.

Body proper fusiform, 0.5×0.1 mm, tapered posteriorly and then abruptly enlarged into haptor. On the flat side of the narrowest posterior region¹⁾ is a membranous plaque with several arcuate transverse ridges, and immediately in front of this there is a group of forwardly directed rose-thorn-shaped hooks, whose number was unable to determine; they are recognizable on the syntype alone, one on the right and two on the left. The spot where the hooks must have been attached is indicated in the type by condensed structure of the subcuticular tissue. Haptor more elongated transversely than body width, with two large unpaired, rod-shaped, parallel, transverse bars apparently fused with each other at the middle and a pair of dorsal spatulate bars, two (dorsal and ventral) pairs of lateral anchors, and few marginal hooklets. Of the unpaired bars the anterior is 85μ long and has paired submedian elevations anteriorly and a shallow depression at the middle, and the posterior is nearly straight, a little shorter than the anterior, with a slight median depression posteriorly. The dorsal and ventral anchors are approximately the same length (30–50μ), each having two roots of unequal length and a sharp recurved point, the longer root of the ventral anchor articulating ventrally with the distal end of the paired bar, while the dorsal anchor articulates with the tip of the bar on the inner surface of its flattened shorter

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1) Distorted in the type specimen.

root, so that the shorter root of the ventral anchor and the longer root of the dorsal anchor are not articulate, though a bundle of fine muscle fibers is attached to their tip. Immediately in front of the middle of the unpaired transverse bar is a deeply staining circumscribed area.

Head truncate in front, with three pairs of large rounded head organs, the last pair projecting very prominently. Of the two pairs of eye spots the granules of the anterior pair are scattered. Pharynx oval, 26–28×15–23μ. Ceca wide, not united posteriorly. Testis elongate oval to pyriform, 78–85×36–44μ, situated a little obliquely just behind ovary. Vas deferens ascending by the side of uterus and leading into fusiform bulbus ejaculatorius, which is 31μ long by 13μ wide in the type, provided with a thick coat of spiral muscle fibers, and situated very close to the genital pore. Cirrus with a large bulbous basal portion, which is 52μ long by 23–20μ wide, and whose lumen is divided into four compartments, of which the largest distal one is produced into a curved hollow spicular filament. A longitudinally elongated prostatic reservoir lies on the left of the uterus, its narrow duct describes a sigmoid curve near the anterior end of the reservoir and finally opens into the basal portion of the cirrus along with the short narrow duct from the ejaculatory bulb. Genital pore some distance (about 60μ in the type) posterior to intestinal bifurcation.

Ovary oval, 49×31μ in the type, postequatorial, a little to right of median line. The germiduct arising from the anterior end of the ovary turns toward the median line and joins the vaginal duct and then the transverse vitelline duct about the midbody; uterus subcylindrical, containing a large elliptical egg which is 62–67μ long by 33–41μ wide, with marked thickening at posterior pole. Vitellaria co-extensive with intestine, confluent dorsal to intestinal bifurcation and posterior to testis; no vitelline reservoir. Vagina with funnel-shaped opening ventral to left cecum a little behind level of genital pore; vaginal duct narrow, convoluted and well chitinized for its greater distal portion, but its narrow proximal portion is not chitinized and difficult to see but can be traced down to the germiduct.

In *Rhabdosynochus* Mizelle et Blatz, 1941, the adhesive plaques are lateral, the cirrus has an accessory piece and the vagina is absent, whereas in the present genus the adhesive plaques are dorsal and ventral, the cirrus has no accessory piece and the vagina is present. In both genera the unpaired transverse bars are fused at their mid-regions, and there are some spines on the body.

Pseudorhabdosynochus n. g.

Generic diagnosis.—Dactylogyridae, Diplectaninae: Body fusiform, spined on each flat surface at posterior tapering portion. Squamodiscs on dorsal and ventral side of haptoral peduncle, each reduced to a membranous plaque with several curved transvdrse ridges. Haptor transversely elongated, with two long slender, unpaired, transverse bars fused at middle, a pair of dorsal bars each articulating with two similar lateral anchors, and few marginal hooklets. Three pairs of head organs and two pairs of eye spots present. Ceca not united posteriorly. Testis postovarian, bulbus ejaculatorius and prostatic reservoir present. Cirrus complex in structure, without accessory piece. Genital pore a little posterior to intestinal bifurcation. Ovary compact, postequatorial; uterus wide, simple; eggs with polar thickening. Vitellaria co-extensive with intestine. Vagina present. No seminal receptacle. Parasitic on gills of marine teleosts.

Genotype: *P. epinepheli* n. sp.

7. *Geneticoenteron lateolabracis* n. g., n. sp.

(Pl. IV, Fig. 16)

Habitat: Gills of *Lateolabrax japonicus* TEMM. et SCHLEG.

Material: A number of mature specimens stained and mounted *in toto*.

Locality and date: Inland Sea of Japan; April 28, 1957.

Body spatulate, 0.65–1.0 mm long by 0.22–0.3 mm broad. Opisthohaptor discoid, about 0.2–0.24 mm in transverse diameter, well constricted off from body proper. Haptoral anchors consisting of two pairs of hooks and an unpaired median and paired submedian supporting rods; median rod V-shaped, 31–38μ long; submedian rod 28–32μ long, with its blumt-pointed, forwardly curved, outer end articulated with shorter root of ventral hook medially; dorsal hook 27–28μ long from anterior end of its rod-shaped root to height of curve, with wing-like subapical expansion, with which it is articulated with the nodular protuberance arising from the posterolateral corner of the submedian connecting rod; ventral hook 30–33μ long from anterior end of longer root to height of curve, bifid at base, with its shorter root articulated laterally with inner surface of curved outer end of submedian rod as mentioned above. Marginal hooklets about 10μ long, their number is unable to make out. Cement glands and ducts confined to haptor. Several head organs arranged along anterolateral margin of head. Two pairs of eye spots dorsal to mouth opening. Pharynx somewhat pear-shaped, 55–80μ in diameter, consisting of a small anterior muscular portion and larger glandular posterior portion, on each side of which is a compact mass of pharyngeal gland cells. The pharyngeal gland ducts are bundled and running along the lateral and posterior borders of the pharynx open into the pharynx at its posterior end. Esophagus very short; ceca wide, with sinuous walls, terminating blindly at posterior end of body proper.

Testis small, oval, 50–90 × 30–50μ, situated immediately behind ovary at junction of middle with posterior third of body. The vas deferens runs forward ventral to the ovary near its left border, and then alongside the uterus, and after forming a loop around the dorsal side of the genital pore opens into the cirrus along with the prostatic duct. There is only one prostatic complex; the tubular prostatic duct or reservoir crosses the vas deferens ventrally at the level of the anterior end of the genital pore. Cirrus a curved plate with its backwardly directed distal margin armed with four pointed denticles ventrally; a longitudinal muscle bundle extends on the concave side from one end to the other. Genital pore longitudinally elongated oval and measuring 35μ in transverse diameter in the type, situated at second sixth of body, 0.15–0.3 mm from anterior extremity.

Ovary retort-shaped, 0.08–0.1 mm in diameter, situated in midregion of body immediately in front of testis with its attenuated distal end medial to right cecum, where the germiduct abruptly turns to the left, and is continued beyond its junction with the vitelline duct into a genito-intestinal duct opening into the left cecum at the same level. The shell gland lies immediately behind the transverse germiduct; the uterus passes across this germiduct dorsally and runs straight forward along the vas deferens to open outside by a common genital pore. Eggs, observed in one specimen only, is oval and 44μ in diameter in collapsed condition, and possesses no polar filament. Vitellaria profusely developed in lateral fields from behind pharyngeal glands to posterior end of body proper, intruding into dorsal median field between genital pore and ovary as well as posterior to testis. No vagina.

This genus, apparently belonging to the Tetraoncinae, is characterized by the two pairs of haptoral anchors being supported by a median and two submedian transverse bars, and the possession of a genito-intestinal duct instead of vagina. The presence of germ cells in the lumen of the left cecum, observed in most of the flattened specimens, is due to the pressure exerted on the cover slip, indicating the direct communication between the germiduct and the left cecum. This is of unique occurrence in the subfamily Tetraoncinae. The generic name refers to the communication between the germiduct and the cecum.

Geneticoenteron n. g.

Generic diagnosis.—Tetraoncinae: Body spatulate, nearly parallel-sided, oculate. Opisthohaptor discoid, with marginal hooklets; haptoral hooks of two pairs, articulated with paired submedian transverse bars, each of which, in turn, is articulated medially with the V-shaped median bar. Pharynx consisting of anterior weakly muscular and posterior glandular portions; pharyngeal glands situated in front of anterior end of vitellaria, opening at posterior end of pharynx. Ceca terminating blindly at posterior end of body proper. Testes immediately postovarian; vas deferens not looped around left cecum, and not forming a definite seminal vesicle. Cirrus complex, without accessory piece; prostatic reservoir single. Genital pore median, postbifurcal. Ovary in midregion of body, immediately pretesticular. Genito-intestinal duct present, no vagina. Shell gland immediately behind transverse germiduct. Eggs oval, without polar filaments. Vitellaria lateral and dorsomedian. Parasitic on gills of marine teleosts.

Genotype: *G. lateolabracis* n. sp.

8. *Murraytrematoides ditrematis* n. g. n. sp.

(Pl. IV, Fig. 14)

Habitat: Gills of *Ditrema temmincki* BLEEKER.
Material: Numerous mature and gravid specimens.
Locality and date: Inland Sea; September 7, 1957.

Body subcylindrical, flattened, 0.4–0.57 × 0.12–0.19 mm. Opisthohaptor well constricted off from body proper, about 0.15 mm wide in the type 0.5 mm long by 0.17 mm wide, marginal hooklets simple, about 8μ long, their exact number not made out; central bar V-shaped, 65–78μ from end to end linearly, paired submedian transverse bars 41–52μ long, with its forwardly directed horn-like outer end articulating with the dorsal root of the ventral anchor and provided dorsally at the base of this horn with a minute knob, with which the shorter dorsal root of the dorsal anchor articulates; dorsal anchor 46–65μ from end of longer ventral root to height of curve; ventral anchor 56–62μ from end of ventral root to height of curve.

Anterior extremity rounded, with head organs arranged in an oblique row on each side, behind which the head gland cells are closely massed together. Two pairs of eye spots present. Mouth funnel-shaped, subterminal. Pharynx rounded or longer than broad, 30–50×30–40μ; esophagus practically absent. Ceca simple, terminating blindly near posterior end of body proper, usually close to each other.

Testis irregular in outline, 36–78×39–78μ, situated immediately behind ovary between two intestinal crura; the vas deferens arising from the anterior end of the testis runs forward dorsal to the ovary and after looping around the left cecum passes obliquely forward across the germiduct and uterus dorsally and forms a small oval seminal vesicle (30×24μ in the type); the ejaculatory duct, greatly dilated dorsal to the cirrus and metraterm, turns backward immediately behind the intestinal bifurcation, where it joins the prostatic reservoir coming from behind, and after a tortuous descending course opens into the base of the cirrus. Prostatic reservoir tubular, parallel to dilated ascending portion of ejaculatory duct, 42μ long by 7μ wide in the type, with its proximal end directed backwards. Prostatic cells massed together immediately in front of distal end of ovary. Cirrus chitinous, consisting of a tricuspid hood-like apex which tapers toward the base in a gentle curve with a muscle bundle extending from base to apex in the concavity. No accessory piece. Genital pore round, provided with few circular and radial muscle fibers, opening midventrally close behind intestinal bifurcation.

Ovary 0.1–0.14×0.065–0.11 mm, situated immediately in front of testis, occupying whole breadth of intercecal area with its long axis parallel to that of body, and its posterior end incised in the median line to enclose the produced anterior end of the testis; the tapering anterior end of the ovary turns round the right cecum, and is continued into a narrow transverse germiduct, which enters the seminal receptacle from the right side and soon emerging close behind its entrance joins the vitelline duct at it crosses the germiduct dorsal to the origin of the latter, where the shell gland cells are converged. The uterus functioning as ootype, is considerably dilated; in the type it is oval and about 40μ wide, and contains an immature egg 52μ long by 39μ wide; the terminal portion of the uterus is differentiated into a metraterm provided throughout with a number of longitudinal internal cuticular folds and a dense coat of glandular cells; in some specimens this metraterm is seen completely evaginated to the outside. It appears, therefore, that this structure serves as an ovijector *sui generis*. Eggs oval, without polar filament, about 45μ in diameter in mounted condition. Vagina lined with cuticle, with a slit-like ventral opening in left submedian line at level of anterior end of ovary; it opens internally into the seminal receptacle, which in turn joins the germiduct on its right side as mentioned above. Vitellaria extending in lateral fields from level of pharynx to posterior end of body proper, intruding into posttesticular intercecal field.

This genus bears a certain resemblance to *Murraytrema* PRICE, 1937, but provided that MURRAY's description be correct, the present genus differs from it in the following essential characters.

1. The vas deferens loops around the left cecum.
2. The prostatic reservoir opens into the ejaculatory duct, and not directly into the cirrus.
3. The ovary loops around the right cecum.
4. The vagina opens ventrally in the left submedian line at the level of the anterior end of the ovary.
5. The unpaired median haptoral bar articulates with the paired bars at its lateral arms.
6. Each marginal haptoral hooklet has a single claw.

Further, the present species differs from *Murraytrema pricei* CABALLERO, BRAVO et GROCOTT, 1955, which undoubtedly belongs to the genus under consideration, in the cephalic region not being delimited from the body proper, in the vas deferens encircling the left cecum, etc. The latter character, however, may have been overlooked in *Murraytrema pricei.*

Murraytrematoides n. g.

Generic diagnosis.—Dactylogyridae, Tetraoncinae. Opisthohaptor with a median and two submedian transverse bars, two pairs of nearly similar anchors, and a number of marginal hooklets. Several pairs of head organs and 2 pairs of eye spots present. Intestinal crura simple, not confluent posteriorly. Testis irregular in outline, postequatorial. Vas deferens encircling left cecum; seminal vesicle formed by mere dilatation of vas deferens. One prostatic reservior present. Cirrus complex in structure, without accessory piece. Ovary tapering distally and encircling right cecum, pretesticular. Vagina opening ventrally in left submedian line at level of anterior part of ovary. Seminal receptacle present. Eggs oval, without filament (?). Vitellaria extending in lateral fields from level of pharynx to posterior end of body proper. Parasitic on gills of marine teleosts.

Genotype: *M. ditrematis* n. sp.

Other species: *M. pricei* (CABALLERO, BRAVO et GROCOTT, 1955) n. comb., on *Muraenesox coniceps*; Canal Zone (Pacific).

9. *Pseudomurraytrema spari* n. g., n. sp.

(Pl. IV, Fig. 17)

Habitat: Gills of *Sparus macrocephalus* BASILEWSKY.

Material: Four mature specimens.

Locality and date: Inland Sea; September 9, 1957.

Body subcylindrical, flat, oculate, 1.0–1.23 × 0.15–0.3 mm. Opisthohaptor well set off from body proper, discoid, with median incision posteriorly, 0.19 mm wide in the type 1.23 mm long, with 14 marginal hooklets and a pair of slender sigmoid transverse bars which are 28μ long, each provided at its outer curved portion with two minute supporting rods 15μ and 13μ long respectively. The paired portions bearing the bars are somewhat elevated ventrally, each containing a large cement reservoir. There is no central bar between the paired transverse bars. Cement glands strongly developed in posterior intercecal field.

Head approximately trapezoidal, 0.15 mm in diameter in the type with median notch anteriorly. Head organs conspicuous with their gland cells massed together lateral to eye sports. Mouth opening ventrally between two pairs of eye spots. Pharynx 80–100μ in diameter; pharyngeal cells massed together anterior and lateral to anterior end of vitellaria; esophagus practically lacking, ceca wide at bifurcation, terminating blindly near posterior extremity of body proper.

Testis longitudinally elongated oval, 0.22–0.28×0.15–0.25 mm, situated in middle third of body, occupying entire breadth of body. Vas deferens turning round left cecum, forming twisted seminal vesicle (33μ wide in the type) medial to the cecum. There is a retort-shaped prostatic reservoir (28μ wide in the type) opening into the cirrus at its base along with the vas deferens; prostatic cells massed together immediately in front of ovary medial to right cecum. Cirrus strongly curved, measuring 44–52μ linearly from obliquely truncated funnel-shaped base to acicular point; accessory piece approximately T–shaped, about 50μ long linearly from acute tip of longer arm to slightly swollen distal point, lying alongside cirrus, with muscle fibers extending from tip of base of cirrus to curved shorter arm of accessory piece. Genital pore median, a little (about 80μ in the type) behind intestinal bifurcation.

Ovary tubular, pretesticular, encircling right cecum, curved at right angles with compact mass of shell gland cells between its two extremities. Uterus simple, short; no eggs observed. Vitellaria extending profusely in lateral fields, surrounding ceca, confluent in median field dorsal and posterior to intestinal bifurcation, between ovary and testis and posterior to testis. Vitelline reservoir transversely elongated, resting on ventral surface of proximal portion of ovary. Vagina well chitinized, narrow, funnel-shaped, opening middorsally at level of anterior part of testis; vaginal duct narrow, opening into fusiform or retort-shaped seminal receptacle which lies across the ventral surface of the proximal part of the ovary alongside the vitelline reservoir and joins the germiduct at its medial end. Paired excretory vesicles opening dorsally at level of posterior end of pharynx.

This species resembles *Murraytrema robustum* (MURRAY, 1931) in the ovarian complex and terminal genitalia, and *Murraytrematoides ditrematis* mihi in the ovary and vas deferens encircling the intestine, but differs fundamentally from either in the haptoral anchors. There is no central bar in the present species and the anchors associated with the paired bars are so much reduced that they are no more functional anchors. That the vagina opens dorsally unlike that of *Murraytrema robustum* is worth noting.

Pseudomurraytrema n. g.

Generic diagnosis.—Dactylogyridae; Tectraoncinae: Body subcylindrical, flat, oculate. Opisthohaptor well set off from body proper, with 14 marginal hooklets, a pair of slender transverse bars each associated with rudimentary anchors, and a pair of conspicuous cement reservoirs. Head organ complex and pharyngeal glands well developed. Two pairs of eye spots present. Intestinal crura simple, teminating blindly near posterior extremity. Testis oval, large, in middle third of body; vas deferens encircling left cecum, dilated medial to left cecum to form tortuous seminal vesicle. Prostatic reservoir opening into cirrus along with vas deferens. Cirrus with accessory piece. Genital pore median, postbifurcal. Ovary pretesticular, tubular, curved, encircling right cecum; uterus simple; eggs? Vitellaria extending in lateral fields, confluent in median field dorsal and posterior to intestinal bifurcation, between ovary and testis and posterior to testis. Vagina opening middorsally at level of testis; seminal receptacle well developed. Parasitic on gills of marine teleosts.

Genotype: *P. spari* n. sp.

10. *Pseudamphibdella paralichthydis* n. g., n. sp.

(Pl. III, Fig. 6)

Habitat: Gills of *Paralichthys olivaceus* TEMM. et SCHLEG.

Material: Three mature specimens.

Locality and date: Inland Sea; September 12, 1957.

Body very small, flattened subcylindrical, tapering toward opisthohaptor which is 4-lobed, 0.11 mm in diameter and well set off from the body proper. Four symmetrical lobes of opisthohaptor separated one from another by a median longitudinal and a transverse groove, two being dorsal and others ventral, each bearing a strongly curved anchor about 31–33μ long from tip of longer root to height of curve and marginal hooklets 10–13μ long; a claviform cement reservoir is seen close to each anchor with its attenuated distal end directed toward the point where the anchor projects over the surface of the lobe; large claviform cement gland cells are massed together at posterior end of body proper.

Head trapezoidal, 0.1–0.11 mm wide, with a group of closely massed head organs on each side. Two pairs of eye spots present. Pharynx 52–78×47–60μ, apparently constricted into two portions; anterior portion consisting of a circle of six large cells each containing a large nucleus, posterior portion composed of very fine muscle fibers; pharyngeal gland cells posterolateral to pharynx, their ducts converging toward posterior end of pharynx and opening into pharyngeal lumen at anterior end of posterior portion of pharynx. Esophagus practically absent; ceca simple, terminating blindly short of posterior end of body proper.

Testis ovoid, 28–39×39–55μ, situated immediately behind ovary; vas deferens looped round left cecum anterolateral to ovary. No seminal vesicle. Prostatic reservoir oval, at base of cirrus. Cirrus acicular, surrounded at base by muscle fibers. Genital pore circular, just postbifurcal.

Ovary rounded, 65–78×65–100μ, just postequatorial. The germiduct arising from the anterior end of the ovary turns back on itself and forms an oval dilatation, where it joins the vitelline duct coming from the transverse commissure, and then receives the shell gland ducts. Shell gland cells massed together anterior to ovary. Uterus divided into a short cylindrical proximal portion and a large oval distal portion, the latter containing in the type a crumpled egg whose polar filament extends straight backward with its somewhat enlarged tip in the above mentioned dilated portion of the germiduct. Neither vagina nor seminal receptacle. Vitellaria extending along ceca from level of pharynx to beyond cecal ends, confluent across median line in front of genital pore as well as in posttesticular intercecal field; paired vitelline ducts passing ventral to proximal portion of uterus.

This species bears a certain resemblance to *Amphibdella torpedinis* CHATIN, 1874, in the character of haptoral anchors, but differs from it in lacking a vagina and seminal receptacle, in the relative position of the ovary and testis, in the anterior extent of the vitellaria, etc. There is no doubt whether it represents a new genus of the subfamily Tetraoncinae.

Pesudamphibdella n. g.

Generic diagnosis.—Dactylogyridae, Tetraoncinae: Body very small. Haptor well constricted off from body proper, with four (two dorsal and two ventral) symmetrical lobes, each lobe bearing a strongly curved anchor and minute marginal hooklets; cement gland complex well developed. Head organ, pharyngeal glands and two pairs of eye spots present. Ceca simple, not united posteriorly. Testis postovarian; vas deferens looped round left cecum. Single prostatic reservoir present. Cirrus acicular, without accessory piece. Genital pore postbifurcal. Ovary comparatively large, pretesticular. Eggs with polar filament. Neither vagina nor seminal receptacle. Vitellaria co-extensive with intestine, confluent anterior to genital pore and posterior to testis. Parasitic on gills of marine teleosts.

Genotype: *P. paralichthydis* n. sp.

Megaloncidea n. superfam.

MEGALONCIDAE n. fam.

11. *Megaloncus arelisci* n. g., n. sp.

(Pl. III, Figs. 2–3)

Habitat: Gill of *Areliscus joyneri* (GÜNTHER).

Material: Three gravid specimens fixed under cover glass pressure, stained with Heidenhain's hematoxylin and mounted *in toto*.

Locality and date: Inland Sea; March 15, 1958.

Body proper flattened fusiform, 0.37–0.5 mm long, 0.94–1.0 mm wide about middle, produced backward into a short stalk, to which an elongate, dorsally convex haptor is attached. Cuticle scattered all over with minute cuticular papillae, which are more numerous at the anterior extremity than elsewhere. Eye spots absent. Haptor 1.2–1.3 mm long, provided on the concave ventral side at certain intervals with three pairs of very powerful anchor complexes, each of which consists of a stout, prismatic basal piece, a basally three-toothed, principal claw with two unequal spine-like processes on concave side and two poorly chitinized saddles on other side near its base, and a nearly straight hollow bar which has a poorly chitinized saddle near its base and a small hammer-shaped tip surmounted by a T shaped accessory piece; the principal claw and hollow bar articulate with the four-toothed apex of the basal piece; the two teeth of the latter interlocking with the two basal teeth of the principal claw, with the other two teeth in direct contact with the remaining tooth of the claw as well as with the two basal teeth of the hollow bar. This fundamental structure of the anchor complex and the mode of articulation are all alike in the three pairs, though distal end of the dorsal saddle of the first and second principal claws is single-barbed while that of the third claw is double-barbed, and the ventral saddle is lacking (?) in the third pair. Measurements in mm of length (linearly from end to end) of each anchor pair are as follows:

pair component	I	II	III
Principal claw	0.28–0.31	0.31–0.4	0.25–0.32
Basal support	0.14–0.2	0.17–0.22	0.18–0.2
Hollow bar	0.2 –0.25	0.2 –0.25	0.19–0.2
Accessory piece of bar	0.07–0.09	0.095	0.085

At the posterior end of the body proper there are profusely developed small unicellular gland cells, probably serving adhesive purposes.

Mouth subapical. A pair of strongly muscular anterior suckers present, each measuring 65–70μ in diameter, with a transverse septum. Pharynx pyriform, 75–85 × 60–67μ. Esophagus with few lateral branches; at this level there is on each side a compact mass of unicellular gland cells. Intestine with narrow lateral branches, which are confined to the vitellarian area and dilated at the outer end reaching to the lateral edge of the body; each cecum is continued into the haptor as a narrow simple duct which extends near the dorsal cuticle as far back as the posterior end of the haptor, giving off at nearly right angles three, narrow, simple, lateral branches, each of which reaches to the base of each haptoral anchor complex. These cecal continuations are accompanied all the way through by light brown pigment granules, which in the fresh state clearly indicate the course of the ducts.

Testes small, subglobular to oval, paved in one layer in median field posterior to ovarian complex, overlapping vitelline follicles laterally but not extending backward beyond posterior limit of vitellaria; their number is unable to count with certainty. Vas deferens running almost straight forward in median field on the right of shell gland and then between vitelline duct and ovary, anterior to which it may be distended with spermatozoa to a maximum width of 40μ and follows a winding ascending course dorsal to the median uterus; its distal portion tapers again as it approaches the ejaculatory duct, which is very narrow and short and provided with circular muscle fibers; cirrus forming an unarmed muscular bulb about 65μ in diameter, and opening directly into atrial sucker. Latter ovoid, 67–70μ in transverse diameter, armed at its opening with a circle of 6 hooks, the convex side of which is fluted longitudinally.

Genital pore opening outside just in front of this genital sucker, at about level of anterior end of vitellaria.

Ovary vermiform, folded back on itself with proximal end directly behind distal end, on the right of median line, measuring 0.37–0.5 × 0.32–0.52 mm as a whole, situated at second sixth of body proper. The germiduct lined with ciliated epithelia arises from the distal end of the ovary and winds its way backward dorsal to the proximal end of the ovary, and forms a peculiar narrow fusiform swelling, toward which are converged numerous fine, gland-duct-like striae, and into which open a number of radial tubular seminal receptacles surrounded by circular muscles; some of these seminal receptacles are dilated at their blind end to form typical seminal sacs of varying dimensions, the largest in the type specimen measuring 90μ in diameter and lying posterior to the point of origin of the genito-intestinal duct. This duct arises from the germiduct just behind the above mentioned fusiform swelling and passes obliquely forward to open into the right cecum. After joining the common vitelline duct, the germiduct turns back on itself and leads into the elongate ootype lying on the left of the median line dorsal to the common vitelline duct. Uterus ventral to ovary and vas deferens, containing one to three eggs; eggs fusiform, produced at each pole into a process about 0.15 mm long. Vitelline follicles profusely developed on each side of body from level of genital pore to near posterior end of body proper, almost confluent in median field anterior to ovary, but leaving the postovarian median field free for the testes; the common vitelline duct arising from the right submedian vitellaria at the level of the anterior end of the ovary winds its way obliquely backward ventral to the ovary, vas deferens, uterus and sheil gland complex and unites with the germiduct a short distance (about 0.1 mm in the type) from the origin of the genito-intestinal duct. Vagina absent. Excretory vesicles situated symmetrically, one on each side of bulbus cirri or genital sucker.

This genus is characterized by the enormous development of the posterior haptoral apparatus consisting of three pairs of anchor complexes, the components of each complex articulating with one another. That the germiduct forms a very peculiar fusiform swelling into which open a number of tubulo-saccular seminal receptacles is also worth noting. From the structure of the opisthohaptor it is certain that this genus belongs in the suborder Monopisthocotylea ODHNER, 1912, but in other characters it bears a marked resemblance to microcotylids without vagina of the suborder Polyopisthocotylea ODHNER, 1912, only differing in the organogenesis of the seminal receptacle. So far as I am aware this organ has been observed to originate from the germiduct in *Cyclobothrium* CERFONTAINE, 1895 and some species of *Microcotyle* BEN. et HESSE, 1863.

In view of these considerations it seems very likely that the present genus shows a linkage between the two suborders Monopisthocotylea and Polyopisthocotylea, but from the fundamental structure of the opisthohaptor as a single unit, to which suborder importance is ascribed, I prefer to assign this genus to Monopisthocotylea, and to propose a new superfamily Megaloncidea, with the following diagnosis.

Megaloncidea n. superf.

Superfamily diagnosis.—Monopisthocotylea: Functional opisthohaptor developed as a single unit in form of an elongate bolster armed with 3 pairs of anchor complexes, each of which consists of a powerful principal anchor interlocking with its basal support and an apically disconnected bar; no marginal hooklets. Prohaptor represented by paired intrabuccal accessory suckers and well developed glandular area. Genitalia of microcotylid type in general pattern, without vagina. Receptaculum seminis arising from germiduct. Parasites of teleosts.

Megaloncidae n. fam.

Family diagnosis.—Megaloncidea: With characters of superfamily.

Megaloncus n. g.

Generic diagnosis.—Megaloncidae: Opisthohaptor elongate, convex dorsally, without marginal hooklet; principal claw long; with two spinelike processes on its slightly concave side and two poorly chitinzed saddles on other side near the base; its basal support stumpy, prismatic, interlocking with principal claw and also articulating with another rather straight hollow bar whose hammer-shaped tip is surmounted by T-shaped accessory piece. Body proper covered with numerous cuticular papillae; anterior extremity with well developed glandular area; eye spots absent. Mouth ventroterminal, two septate oral suckers in buccal cavity; pharynx pyriform, esophagus with side branches; Intestine also with numerous narrow lateral branches, each cecum continued backward to posterior end of opisthohaptor as a simple narrow duct giving off three similar lateral branches, one for each anchor complex. Testes divided into numerous small follicles, in postovarian median field. Vas deferens winding in median line anterior to ovary; ejaculatory duct differentiated but very short; cirrus in form of a muscular bulb; genital atrium with armed basal sucker, at the center of which opens the bulbus cirri; genital pore opening midventrally just in front of this genital sucker at level of anterior end of vitellaria. Ovary vermiform, folded back on itself with both extremities close together; germiduct forming a fusiform swelling, into which open a number of tubulo-saccular seminal receptacles and numerous fine ducts of unknown glands (?). Genito-intestinal duct originating from germiduct just distal to this peculiar swelling and opening into right cecum. Shell gland complex postovarian, left of median line. Uterus running straight forward ventral to winding vas deferens; eggs with polar prolongation at each pole. Vitellaria follicular, co-extensive with intestine and its branches except posterior cecal prolongations intruding into opisthohaptor; common vitelline duct arising from right submedian vitellaria at level of anterior end of ovary, uniting with germiduct before the latter turns back on itself to lead into the ootype. Vagina absent. Excretory vesicles symmetrical, one on each side of bulbus cirri or genital sucker. Parasitic on gills of marine teleosts.

Genotype: *M. arelisci* n. sp.

POLYOPISTHOCOTYLES ODHNER, 1912

Diclidophoroidea PRICE, 1936

Diclidophoridae FUHRMANN, 1928

12. *Osphyobothrus parapercis* n. g., n. sp.

(Pl. III, Figs. 8–9)

***Habitat*:** Gill of *Parapercis pulchella* TEMM. et SCHLEG.

Locality and date: Aquarium of Tokyo University at Shinmaiko, Aichi Pref.; May 14, 1958.

A single mature but not gravid specimen was fixed in Schaudinn's solution under a cover slip after it had been examined in the fresh state, and stained and mounted as usual.

Body tapered anteriorly and enlarged posteriorly, with a wide median sinus at posterior extremity, 2.65 mm in length from head end to base of posterior sinus, about 1.0 mm in width at anterior end of haptor. Haptor not set off from body proper, with four pairs of pedunculate clamps of nearly same size. Just in front of the posterior sinus is embedded in the body parenchyma a well defined rounded muscle bulb measuring 0.2 mm long by 0.18 mm broad and possessing a longitudinally elongated oval central pit opening on the dorsal surface. This bulb consists of very fine lamellar circular muscle fibers, radial muscle fibers converged toward the opening of the pit, and nine, transversely striated, powerful, longitudinal muscle bands separated from one another by interstitial connective tissue. In the fresh state the bulb was seen actively changing its size and shape by the contraction of the longitudinal muscle bands. Dorsally outside the bulb, especially anterior to the opening of the pit, there are strongly developed circular lamellar muscle fibers, probably associated with the contraction of the bulb.

The chitinous framework of the clamp consists of a T-shaped ventral piece with its long arms reaching to the outer basal corner of the clamp skeleton and a similar T-shaped dorsal piece with its long curved arms articulating on each side with a shorter lateral piece arising from each basal corner of the skeleton. A short free piece is given off inwards from the outer corner of the skeleton. The dorsal and ventral median stems are articulated with each other at the base, where they are pushed outward by the dome-like pad, to which the powerful clamp fixer is attached, and which is surmounted by an arcuate chitinous bar connecting the base of the median stems with the inner basal corner of the clamp skeleton. The medial surface of the ventral stem is denticulate as shown by SPROSTON for *Diclidophora merlangi*. The non-chitinous walls of the dorsal and ventral valves do not show and particular structure. The gross pattern of the skeleton of the clamp is similar to that of *Diclidophora merlangi* as illustrated by SPROSTON in her figure 112f, though different in minor details.

In front of the wide subterminal mouth opening is a conical median projection, at the apex of which open the sticky gland ducts close together. At each lateral corner of the mouth aperture opens a bundle of cervical gland ducts coming from the gland cells which are massed together on each side in the neck region. Paired anterior suckers 0.1 mm long by 0.06 mm wide, with a wide cleft-like opening ventrally and medially and no septum. A slender muscle bundle is attached to the posteroventral end of each sucker; as it passes by the pharynx it is reinforced by additional fibers, the innermost of which cross each other posteroventral to the pharynx, the remaining fibers are dissociated as they run backward and merged sooner or later into the ventral subcuticular muscle layer. Pharynx pyriform, poorly muscular, 0.1 mm in diameter, with its anterior opening bordered with thick cuticle. Esophagus bifurcating immediately in front of genital pore. Ceca with numerous outer and inner branches, but not confluent posteriorly; one of the left posterior branches, crossing the median line anterior to the above mentioned caudal muscle bulb, runs down to the base of the peduncle of the right posteriormost clamp, parallel to the posteriormost branch of the right side; the outer branches reaching to the lateral edge of the body or the base of the peduncle of each clamp show for the most part a conspicuous terminal dilation. The parietal pigment cells are well developed to the whole extent of the intestine and its branches.

Testes subglobular to oval, or elliptical, about 30 in number, situated in a zigzag row (or irregular double row), mostly in postovarian median field; some of them are seen on the right of the ovary and vitelline reservoir. Vas deferens running straight forward dorsal to uterus, describing a sigmoid curve before opening into genital atrium by a typical sucker which corresponds to the bulbus cirri, but not to the common genital sucker in the strict sense of the word. This sucker, 39×44μ, consists exclusively of meridional muscle fibers, and has a definite outer limiting membrane, and is lined with cuticle at the central opening, its anterior ventral surface giving a file-like appearance. The genital atrium proper, at the base of which opens the above mentioned sucker, is provided inside near its opening with a ring of eight cuticular tubercles, each of which bears a slightly curved, inwardly directed spine. The relatively small, common, genital pore opens at the center of this armed coronet at a distance of 0.32 mm from the tip of the frontal projection.

Ovary approximately W-shaped, 0.35×0.38 mm, situated near midregion of body; its proximal end folded upon itself, and the next middle portion crossing the genito-intestinal duct, germiduct, vitelline reservoir and uterus dorsally, the distal portion 0.14 mm wide is directed forward, giving off the germiduct at its anterior end. The germiduct runs transversely to the right along the convex side of middle portion dorsal to the uterus and vitelline reservoir and then backward, and joins the genito-intestinal duct just before crossing the ovary on its ventral side. After crossing the ovary and vas deferens it receives the duct from the vitelline reservoir. There is no receptaculum seminis as observed in *Diclidophora merlangi*. The elongate fusiform ootype lies ventrally in the free space formed by the arcuate middle portion of the ovary and contains a number of yolk cells and shell material together with a germcell in the process of egg formation. Uterus straight, median, ventral to vas deferens, provided with inner longitudinal and outer circular muscles and lined with long cilia directed forward. Though narrow proximally it gradually widens distally, attaining a maximum diameter of 42μ before entering the genital atrium ventral to the male terminal sucker. Vitelline follicles occupying all available space of body from level of intestinal bifurcation to base of peduncles of clamps; vitelline reservoir elongate, widest at its base where the two vitelline ducts join together, extending longitudinally on the right of uterus and ootype, with its tapered distal portion crossing the ovary on its ventral side. Vagina absent.

This genus bears a marked resemblance to *Diclidophora* DIESING, 1850, in general anatomy, but differs distinctly in the absence of seminal receptacle and the presence of a muscle bulb opening dorsally at the lower part of the back, to which the new generic name refers.

Osphyobothrus n. g.

Generic diagnosis.—Diclidophorinae: Body proper undivided, tapered anteriorly and widened posteriorly. Haptor not clearly set off from body proper; clamps pedunculated; the dorsal valve is supported by a T-shaped median piece and a pair of lateral basal pieces articulating with the lateral arms of the median piece, while the ventral median piece sends out a pair of long lateral arms reaching to basal corners of the clamp; the stems of the dorsal and vental median pieces are articulated at the base and pushed outward by the pad, to which the clamp fixer is attached and which is surmounted by an arcuate chitinous bar connecting the base of the median stems with the inner basal corner of the clamp skeleton. A short free piece is given off inwards from the outer basal corner of the skeleton. Just in front of the median posterior sinus of the haptor is an ovoid contractile muscle bulb opening dorsally and containing a number of transversely striated, longitudinal muscle bands. Anterior end of body proper tapering to a small conical projection; mouth subterminal, with wide aperture; cervical glands well developed, with their ducts opening at each lateral corner of mouth aperture; anterior suckers opening widely into mouth cavity, without septum; pharynx weakly muscular. Intestine with numerous inner and outer branches but not confluent posteriorly; posterior outer branches reaching to base of peduncles of clamps. Testes numerous, largely median and postovarian, some of them lateral to ovary and vitelline reservoir. Distal end of male duct modified into sucker which opens into the genital atrium at its base. Genital atrium provided with a coronet of eight cuticular tubercles, each of which bears an inwardly pointing spine. Common genital pore opening at center of this coronet just behind intestinal bifurcation. Ovary approximately W-shaped with its distal end directed forward, situated near midregion of body. No receptaculum seminis. Genito-intestinal duct present. Eggs? Vitellaria co-extensive with intestinal branches; main bulk of vitelline reservoir longitudinally elongated immediately anterolateral to ovary. No vagina. Parasitic on gills of marine teleosts.

Genotype: *O. parapercis* n. sp.

13. *Cyclobothrium semicossyphi* YAMAGUTI, 1938

Four gravid specimens found in *Semicossyphus reticulatus* from the Inland Sea gave the following measurements.

Body 1.4–2.2×0.55–0.75 mm. Opisthohaptor 0.45–0.66 mm in diameter. Genital corona 35–40μ in diameter. Anterior testes 5–10 in number, posterior testes 12–17. Ovary 0.18–0.2×0.21–0.34 mm. Eggs 120–170×60–65μ.

The seminal receptacle is distinctly septate, rosette-shaped, though not properly illustrated in my original drawing. Clamp similar in fundamental structure to that of the genotype.

14. *Heterobothrium tetrodonis* (GOTO, 1894) CERF., 1895

Habitat: Gills of *Sphaeroides xanthopterus* TEMM. et SCHLEG.
Material: Four mature specimens, of which two were fully gravid, fixed in Schaudinn's solution under cover glass pressure.
Locality and date: Sagami Bay; June 7, 1958.

Since this material is poorly stained, I shall confine myself to a mere supplementary note on the egg and the skeleton of the clamp, which are not described by GOTO.

On the mounted slides the fusiform eggs measured 140–180μ by 70–90μ, with a long filament at each pole.

The anterior valve of the clamp is supported by a T-shaped median piece, while the posterior valve has an arcuate marginal rod without median stem. The anteromedial basal frame forms a large, approximately rectangular, excavated plate, the anterior inner corner of which is articulated by means of an intercalated piece with the end of the inner arm of the anterior median piece, and the anterior outer corner of which is produced toward the inner end of the arcuate rod of the posterior valve. At the posterior inner corner of the clamp the three-jointed outer arm of the median piece and the arcuate rod are articulated near the base of the latter rod. The T-shaped median piece is articulated at the base on the outer side directly with the posterolateral corner of the above mentioned basal plate, but on the inner side it rests on a small chitinous mass, which in turn fits into the concavity of the bifid protuberance on the inner margin of the basal plate.

Microcotylidae TASCHENBERG, 1879

15. *Microcotyle gimpo* n. sp.

(Pl. IV, Fig. 15)

Habitat: Gills of *Enedrias nebulosus* (TEMM. et SCHLEG.)
Material: One immature and two mature specimens.
Locality and date: Inland Sea; Sept. 9 (type date), April 30, 1957.

Body fusiform, 1.3–2.5 × 0.35–0.6 mm. Cotylophore with 58 and 64 clamps respectively in two mature specimens, but 32 in immature specimen, clamp skleteton measuring up to 52μ in diameter, with accessory piece for posterior ramus of middle piece. Anterior extremity rounded, with a middorsal and two paired lateral groups of head organs. Anterior sucker with distinct partition, 30–40μ in transverse diameter; pharynx 41–62 × 34–41μ. Esophagus wide, bifurcating immediately behind genital pore; ceca with numerous outer branches reaching lateral margins of body, left cecum intruding into cotylophore further backward than right one.

Testes 13–18 in number, occupying whole postovarian intercecal field. Vas deferens winding dorsal to uterus; a short pars prostatica surrounded by prostate cells well differentiated, opening directly into posterior portion of genital atrium at tip of hemispherical protuberance. Preatrial bulb surrounded by lamellar muscle layer, containing minute granules, opening into genital atrium posteroventrally. Genital atrium divided into reniform anterior portion which is 0.075–0.15 mm in diameter, surrounded by radial muscles and covered inside with minute spines, and a bowl-shaped posterior portion which is 0.038–0.11 mm in diameter, sparsely spined on each lateral inner surface, and opens outside ventrally. The dorsal wall of this posterior portion has a shallow circular pit just dorsal to the above mentioned hemispherical protuberance. Genital pore surrounded by radial and circular muscle fibers, lined with folded cuticle.

Ovary shaped like an interrogation mark as usual, with proximal portion resting on anteriormost testes, 0.2–0.28 mm anteroposteriorly, situated at broadest part of body. Germiduct convoluted, forming cylindrical seminal receptacle just before giving off genito-intestinal duct, which proceeds obliquely forward along the posteroventral border of the seminal receptacle. Shell gland situated on the left of posterior end of unpaired vitelline duct. Uterus dorsosinistral to unpaired vitelline duct, crossing left vitelline duct ventrally. Egg fusiform, thick-shelled, 0.13 mm long by 56μ broad, tapering into a short blunt-pointed process at one end and a longer pointed process at the other. Vitellaria surrounding ceca and their branches; paired vitelline ducts joining together anterior to ovary. Vagina elliptical, opening middorsally at a distance of 0.3–0.32 mm from anterior extremity; vaginal duct extending sinuously in dorsal median field from vagina to middle of transverse commissure of paired vitelline ducts. Paired lateral excretory pores at level of genital pore.

This species is characterized by the pars prostatica directly opening into the genital atrium at the tip of a hemispherical protuberance.

16. *Microcotyle sciaenae* GOTO, 1894

18 mature specimens of this species were found on the gills of *Nibea schlegeli* (BLEEKER) (= *Sciaena sina*) from Sagami Bay, June 6, 1958. As compared with GOTO's original description the present material agrees completely in the most important specific characters, especially in the armature of the genital atrium, but differs in some points of minor significance which are given below.

The esophagus is shown in GOTO's figure 6 as a simple narrow tube, but in all the specimens at my disposal it has two or more outpocketings on each side, and the intestinal limbs with numerous outer and inconspicuous inner branches terminate in the cotylophore at distinctly different levels, left one being the longer with only one exception. GOTO says, "No branches on the median side of the intestine, the two trunk of which extend far into the caudal disc and are in this region wholly destitute of lateral branches; the right trunk describing a larger curve in consequence of the general asymmetry of the body".

The asymmetrical cotylophore bears more numerous clamps on the right side than on the left or vice versa without any definite correlation with the side on which the longer cecum occurs; 58–86 clamps (75 after GOTO) in the longer row, and 56–75 clamps (60 after GOTO) in the shorter row, the total number varying from 114 to 157. The number of the testes varies from 13 to 30, whereas GOTO gives it as about 29.

The measurements made on the present material which was subjected to cover glass pressure when fixed in Schaudinn's solution are as follows:

Body 3.1–4.4 mm long, 0.44–0.8 mm broad just at level of testes; anterior buccal sucker 62–80 × 33–52μ, pharynx 41–56 × 31–44μ; genital atrium 78–117μ in inside diameter, genital sucker at base of genital atrium shaped like flower-pot, 56–86 × 46–65μ, bearing a midventrally interrupted circle of 12–15 rods about 20μ long; longer ventral atrial rod up to 65μ long, shorter dorsal atrial rod up to about 18μ in median field. Genital and vaginal pores 0.14–0.17 mm and 0.4–0.7 mm respectively from anterior extremity. Ovary 0.22–0.5 × 0.18–0.3 mm. No mature eggs observed.

17. *Microcotyle sebastisci* n. sp.

(Pl. IV, Fig. 13)

Habitat: Gills of *Sebastiscus marmoratus*, *Sebastodes güntheri*, *Sebastichthys pachycephalus* and *Epinephelus akaara*.

Material, locality and date: 20 mature specimens from *Sebastiscus marmoratus* (type host) from Inland Sea (April 30, 1957), 8 specimens from *Epinephelus akaara* from Inland Sea (September 9, 1957), 2 specimens from *Sebastodes güntheri* from Inland Sea (March 15, 1958), and 11 specimens from *Sebastichthys pachycephalus* from Sagami Bay (June 5, 1958).

Described from mature specimens alone. Body flattened fusiform, 1.7–4.4 mm in length, with maximum breadth of 0.7–1.1 mm in midregion of body proper; cotylophore wedge-shaped, with 29–62 clamps in all; 11–31 clamps on each side, equal or unequal in number, slightly diminishing in size posteriorly; largest clamp near anterior end of cotylophore, about 80μ in transverse diameter, with simple pointed accessory piece for posterior ramus of median piece like that of *Microcotyle sebastis* GOTO, 1894. Anterior extremity forming a flat elevation beyond anterior suckers; latter 40–60 × 50–80μ, with distinct partition at middle; pharynx globular, 40–78 × 40–80μ. Esophagus with sinuous walls, sending off few lateral diverticles, bifurcating just behind genital pore. Ceca with irregular outer and inner branches, right one terminating at posterior end of body proper, left one extending some distance into cotylophore.

Testes 8–20 in number, occupying whole postovarian intercecal area. Vas deferens winding forward dorsal to uterus; its distal portion well differentiated and leading into conical cirrus, which projects into the funnel- or cup-shaped posterior recess of the genital atrium, the lateral wall of which is spined, though sparsely, like the genital atrium proper. The genital atrium surrounded by radiating muscle fibers is approximately reniform, with maximum inside diameter of 0.1-0.24 mm, and covered inside with short spines except at the median anterodorsal area, whence a bulbous fibrous swelling well delimited from the surroundings projects forwards as preatrial bulb, but occasionally this bulb may be flattened or may project into the genital atrium. Genital pore transversely elongated oval, close to median posterior border of genital atrium proper.

Ovary 0.2–0.55 × 0.2–0.6 mm, in form of an interrogation mark, with the attenuated proximal portion turned back on itself in front of anteriormost testis, and the distal portion also folded upon itself and arched across the median field behind middle of body proper; germiduct winding, may be distended with sperm before giving off genito-intestinal duct, which passes toward the right cecum between the germiduct and the winding proximal portion of the ovary. The ootype lies on the left of the ascending portion of the ovary dorsal to the unpaired vitelline duct which joins the germiduct just distal to the origin of the genito-intestinal duct. Uterus median, ventral to vas deferens, opening into posterior recess of genital atrium ventral to cirrus; eggs 0.2–0.22 mm long by 0.09–0.1 mm wide, with a very long filament at anterior pole and a much shorter filament at posterior pole. Vitelline follicles surrounding ceca except for posterior end of left cecum extending into cotylophore. The paired vitelline ducts distended with yolk cells follow a short sinuous descending course, one on each side of the uterus and connected with each other by a transverse commissure anteriorly and by a Y-shaped commissure posteriorly ventral to the arcuate distal portion of the ovary. Vagina transversely elongated oval, opening middorsally by a small aperture some distance back of intestinal bifurcation; it is connected with the transverse vitelline commissure by a median vaginal duct running dorsal to the vas deferens. Excretory vesicles tubular, paired, oblique, opening laterally at level of preatrial bulb by means of several minute pores.

This species most closely resembles *Microcotyle tanago* YAMAGUTI, 1940, in the general shape of the body, but differs from it in the presence of a prominent conical cirrus projecting into the posterior chamber of the genital atrium, and from *M. ditrematis* YAMAGUTI, 1940, in the shape and structure of the genital atrium, though similar in the structure of the cirrus. In *M. caudata* GOTO, 1894, and *M. sebastis* GOTO, 1894, from the related host species, the clamps are nearly alike in number, but the testes are somewhat more numerous (23 and 40 respectively according to GOTO). The eggs are 0.18 mm long by 60μ broad in *caudata* but much larger in the present species.

18. *Microcotyle tanago* YAMAGUTI, 1940

With addition of two mature specimens found in *Ditrema temmincki* BLEEKER from the Inland Sea this species is defined as follows; the original description of the species was based on a single mature specimen!

Body fusiform, 1.5–4.1 mm long by 0.36–0.8 mm broad. Cotylophore 0.75–1.3 mm long, clamps 50–90 in total number, 38–85μ in diameter, without accessory piece for posterior ramus of median piece. Anterior extremity truncate. Anterior suckers with distinct partition, 30–60 × 48–68μ; pharynx 36–57 × 36–60μ, esophagus with a pair or two of side branches, bifurcating immediately behind genital pore. Ceca with inner and outer branches, left one extending some distance into cotylophore. Testes 11–24 in number, massed together in one layer in postovarian intercecal field. Vas deferens winding dorsal to uterus, forming a minute papilliform projection into the genital atrium. Genital atrium consisting of densely spined reniform anterior portion surmounted by an apparently solid bulbous swelling up to 0.11 mm in diameter and well delimited from the surroundings by lamellar fibers, paired lateral recesses surrounded by short radial muscles, and a bowl-shaped posterior median recess, into which open the vas deferens and uterus at the base. This median recess is up to 90μ in diameter, sparsely spined internally on each side, and opens to the outside anteroventrally immediately behind the densely spined reniform portion, with the somewhat depressed central area (about 40μ in diameter) of its dorsal wall covered with comparatively long hairs.

Ovary in form of interrogation mark, 0.18–0.8 mm anteroposteriorly, with its proximal end directly in front of anteriormost testes; germiduct winding, giving off genito-intestinal duct just before uniting with vitelline duct. Ootype situated dorsolateral to descending unpaired vitelline duct; uterus running straight forward in ventral median field. Eggs fusiform, with long filament at each pole, about 80μ in diameter. Vitellaria surrounding ceca and their branches throughout except for their anterior end; paired vitelline ducts joining together ventral to anterior arch of ovary. Vagina oval to elliptical, 40–70μ long by 30–50μ broad, opening middorsally at its anterior end at a distance of 0.3–0.8 mm from anterior extremity.

19. *Prosomicrocotyla gotoi* (YAMAGUTI, 1934) n. comb.

Habitat: Gill of *Hexagrammos otakii* JORD. et ST.
Locality and date: Ise Bay; April 2, 1958.

25 mature of gravid specimens flattened under cover glass pressure, stained and mounted *in toto* showed the following variations.

Body 3.9–5.5 mm in length, 0.83–1.6 mm in width at level of ovary. Pedunculate clamps arranged in form of a frill around posterior half of body, varying in number on each side from 25 in youngest mature specimen 2.9 mm long to 52 in largest gravid specimen 5.5 mm long, commencing at level of ovary. Septate anterior sucker 54–75μ in longer transverse diameter and 36–54μ in shorter diameter, pharynx 59–87 × 54–78μ. Testes 40–90 in number, in postovarian median field, terminating short of posterior extremity, which is usually concave or more or less deeply notched. Genital atrium forming armed sucker-like structure 62–99μ long by 52–88μ wide, esophageal or bifurcal. Ovary vermiform, folded back on itself, measuring as a whole 0.4–1.0 × 0.3–0.7 mm. Uterus distended in fully gravid specimens in form of a spindle or a lemon; eggs 190–221μ long by 72–111μ wide; anterior polar filament very long and coiled, posterior shorter, with recurved tip.

This species and *P. chiri* (GOTO, 1894)[1] are characterized by the body being oval to spatulate, and the haptor being divided into two separate frills, each of which is attached to the posterior lateral margin of the body, commencing at the level of the ovary. In all the known members of *Microcotyle* the body is lanceolate, and the haptor is undivided, the two frills meeting posteriorly. For these reasons the former are separated from the latter as representing a separate genus, for which the name *Prosomicrocotyla* is suggested in reference to the anterior position of the haptor.

Prosomicrocotyla n. g.

Generic diagnosis. Microcotylinae: Body spatulate. Haptor divided into two separate frills bordering posterior half of body proper, commencing at level of ovary and not meeting posteriorly; each frill bearing a row of numerous clamps of uniform structure. Terminal anchors absent. Esophagus simple or with lateral diverticula; intestinal crura with outer branches; inner branches, however, may be present or absent. Testes numerous. Cirrus not differentiated. Genital atrium forming a sucker-like structure armed with spines. Genital pore esophageal or just prebifurcal. Ovary convoluted, with distal end directed backward, median, pretesticular. Genito-intestinal duct crossing proximal portion of ovary. Egg filamented at each pole. Vagina single, with middorsal opening; vaginal duct inverted Y-shaped. Vitellaria entirely or largely co-extensive with intestine and its branches. Parasitic on gills of marine teleosts.

Genotype: *P. gotoi* (YAMAGUTI, 1934), on *Hexagrammos otakii*; Ise Bay, Inland Sea, Japan.
Other species: *P. chiri* (GOTO, 1894), on *Hexagrammos otakii*; Hakodate, Japan.

20. *Axine* (*Axinoides*) *sebastisci* n. sp.

(Pl. III, Fig. 10)

Habitat: Gills of *Sebastiscus marmoratus* CUV. et VALENC.
Material: Three mature specimens.
Locality and date: Inland Sea; September 14, 1957.

Body 2.25–2.5 mm long, 0.7–0.8 mm broad at posteror end of body proper, whence it tapers gradually toward the level of the anterior end of the vitellaria, then abruptly narrowed to a slender, blunt-pointed, anterior extremity, which has a median incision in front and a minute median papilla anterodorsally. Anterior sucker 20–30μ in diameter, without partition, though the anterior and posterior margins are elevated at the middle; pharynx 15–18$\times$13–15μ. Esophagus 0.35–0.5 mm long, with sinuous walls, bifurcating just behind genital pore. Ceca with numerous, narrow, side branches, terminating at posterior extremity of body proper, which is slightly constricted off from the cotylophore provided with a row of 38-42 clamps. Each clamp skeleton consisting of an unpaired, U-shaped, median piece with bifid ends, two pairs of lateral and two pairs of apical, marginal pieces supporting the anterior and posterior valves, and a pair of shorter internal pieces, each of which is directed toward the end of the posterior arm of the median piece along the inner surface of the posterior valve, with its point projecting internally over the surface of the valve.

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[1] In this species the testes are about 25 in number.

Testes rounded 14–30 in number, massed closely together in one layer and occupying whole postovarian intercecal area. Vas deferens winding forward ventral to ovary, then on the right of uterus and finally dorsal to latter; pars prostatica well differentiated, elliptical, 15μ in diameter in the type; prostatic cells massed together on each side of body from level of pars prostatica to that of genital pore; cirrus disc-shaped, 30–40μ in diameter, and provided at its central opening with numerous spines which are arranged in two or three circular rows.

The cirrus and uterus open into the genital atrium which in turn opens outside by a large, oval, midventral aperture (42μ in transverse diameter in the type) surrounded by circular muscle fibers at a distance of 0.4–0.5 mm from the anterior extremity.

Ovary turned back on itself posteriorly, with its anterior portion on the right of median line; the germiduct arising from the anterior end of the ovary turns mesad abruptly at the point where the genito-intestinal duct is given off, and after joining the common vitelline duct runs backward and then turns back on itself to lead into the ootype, the latter extends forward from the left side of the ovary to the level where the ascending genito-intestinal duct opens into the right cecum. Uterus running straight forward ventral to vas deferens. Vitellaria extending profusely along intestine and its branches from a short distance (0.1 mm in the type) behind vagina to near cotylophore, anterior portion of intestine free of vitellaria; paired vitelline ducts joining together a short distance (0.12 mm in the type) behind anterior end of vitellaria, unpaired duct long, descending in median line ventral to uterus. Vagina funnel-shaped, covered inside with dentiform spines, opening middorsally at the level where the body tapers abruptly, 0.1–0.12 mm behind genital pore. Vaginal duct narrow, apparently continued backward toward junction of paired vitelline ducts, from which a narrow median duct can be traced forward for a short distance. In front of the vaginal pore is a shallow depression, from which projects dorsad a blunt-pointed spine 18μ long as in *A. tylosuri* YAMAGUTI, 1938.

POLYSTOMATOIDEA PRICE, 1936

Hexabothriidae PRICE, 1942

21. *Squaloncocotyle laymani* n. sp.

(Pl. IV, Fig. 12)

Habitat: Gills of *Mustelus manazo* (BLEEKER).
Material: 5 gravid specimens.
Locality and date: Inland Sea; April 30, 1957.

Body very much elongated, tapered anteriorly, 8.5–14 mm long by 1.2–1.4 mm broad. Of the three pairs of haptoral suckers one opposite the appendix is somewhat smaller than the other two, 0.32–0.36 mm in diameter, and the sclerite measures 0.6–0.62 mm inclusive of its apical hook, while the other suckers are 0.35–0.38 mm in diameter, with the sclerite and hook measuring 0.75-0.92 mm in combined length; haptoral appendix 0.8–1.1 mm long by 0.4–0.53 mm wide, its apical suckers barrel-shaped, 0.12-0.14 mm in diameter, 0.21 mm in length including basal accessory sucker, which is well constricted off from the main sucker lined with thick strongly sclerotized cuticle; paired anchors situated near apex of haptoral appendix about 40–50μ long, with V-shaped root.

Oral sucker subterminal, surmounted by prominent semicircular hood 0.31–0.39 mm in transverse diameter, followed by short prepharynx; pharynx oval, 70–110μ in diameter. No esophagus. Ceca with short inner and longer outer branches, united at posterior end of body proper, common cecum sending a long simple branch into haptoral appendix and another short one toward the opposite direction.

Testes rounded, very numerous (100 or more), arranged close together in one layer in postovarian intercecal field. Vas deferens strongly winding in median field dorsal to uterus, its distal portion is provided with circular muscles for a distance of 0.12–0.25 mm; pars prostatica 0.1–0.15 mm long, well marked off from distal muscular portion of vas deferens, somewhat enlarged anteriorly in form of a narrow funnel; prostatic cells grouped around vas deferens and uterus far back of pars prostatica. Cirrus forming a large oval bulb 0.13–0.15 mm long by 0.12–0.15 mm wide and composed of meridional muscle fibers, opening at center of genital atrium almost entirely occupied by bulbus cirri, with a large circular aperture, whose margin is fringed with very minute pointed filaments.

Ovary 0.85–1.4 mm long by 0.4–0.5 mm wide, irregularly multilobed, or rather branched at some places, turned back on itself near its distal end, which lies about the middle of the body proper. The anterior end of the ovary extends further forward than the vitelline reservoir. The narrow winding germiduct first joins the seminal receptacle which is elongated elliptical, 0.25–0.42 mm long by 0.05–0.12 mm wide, and lies obliquely just in front of the distal end of the ovary, and then the ductus genito-intestinalis opening into the right cecum; close to this junction the germiduct receives the duct from the vitelline reservoir, and finally turning back on itself leads into the ootype. At this point is a sphincter-like thickening. Ootype very strongly developed, elliptical to fusiform, surrounded by shell gland ducts, shell gland cells lying well apart from ootype. Uterus ventromedian, opening into genital atrium ventral to bulbus cirri; eggs fusiform, about 0.2 mm long, with a comparatively short filament (0.1–0.15 mm) at each pole, total length about 0.45 mm. Vitellaria extending along ceca from a short distance behind genital pore to near posterior end of body proper, leaving posterior end of paired ceca free or not. Vitelline reservoir Y- or T-shaped, dorsal to ovary. Vagina double, each opening ventrally near lateral margin of body at level of bulbus cirri, with villous lining at its comparatively wide distal portion, narrowed as it proceeds obliquely inwards and backwards; vaginal ducts very narrow, without above mentioned lining, parallel to each other, each opening into arm of vitelline reservoir on its own side.

The present species, apparently identical with *Squaloncocotyle* sp. of LAYMAN

(1931) from the same host species of the Sea of Japan, very closely resembles *Squaloncocotyle somniosi* (CAUSEY, 1926) from the Pacific coast of America, but in the latter species the egg has a single short filament. In *S. sphyrnae* MACCALLUM, 1931, the hook of the haptoral sclerite is comparatively long. In *S. catenulata* GUBERLET, 1933, from a related host, the ovary extends forward beyond the arms of the vitelline reservoir just as in the present species, but the germiduct is stated to be convoluted before leading into the ootype, and the egg has a very long filament at one pole but none at the other pole.

Acknowledgements

I wish to express my gratitude to the Enoshima Aquarium at Katase, Kanagawa Prefecture, the Seto Marine Biological Laboratory of Kyoto University, the Tamano Marine Laboratory of Okayama University, and the Oceanographical Museum of Tamano City, Okayama Prefecture, for their generous supply of the fish materials, from which the parasites described here were collected.

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EXPLANATION OF PLATES III-IV

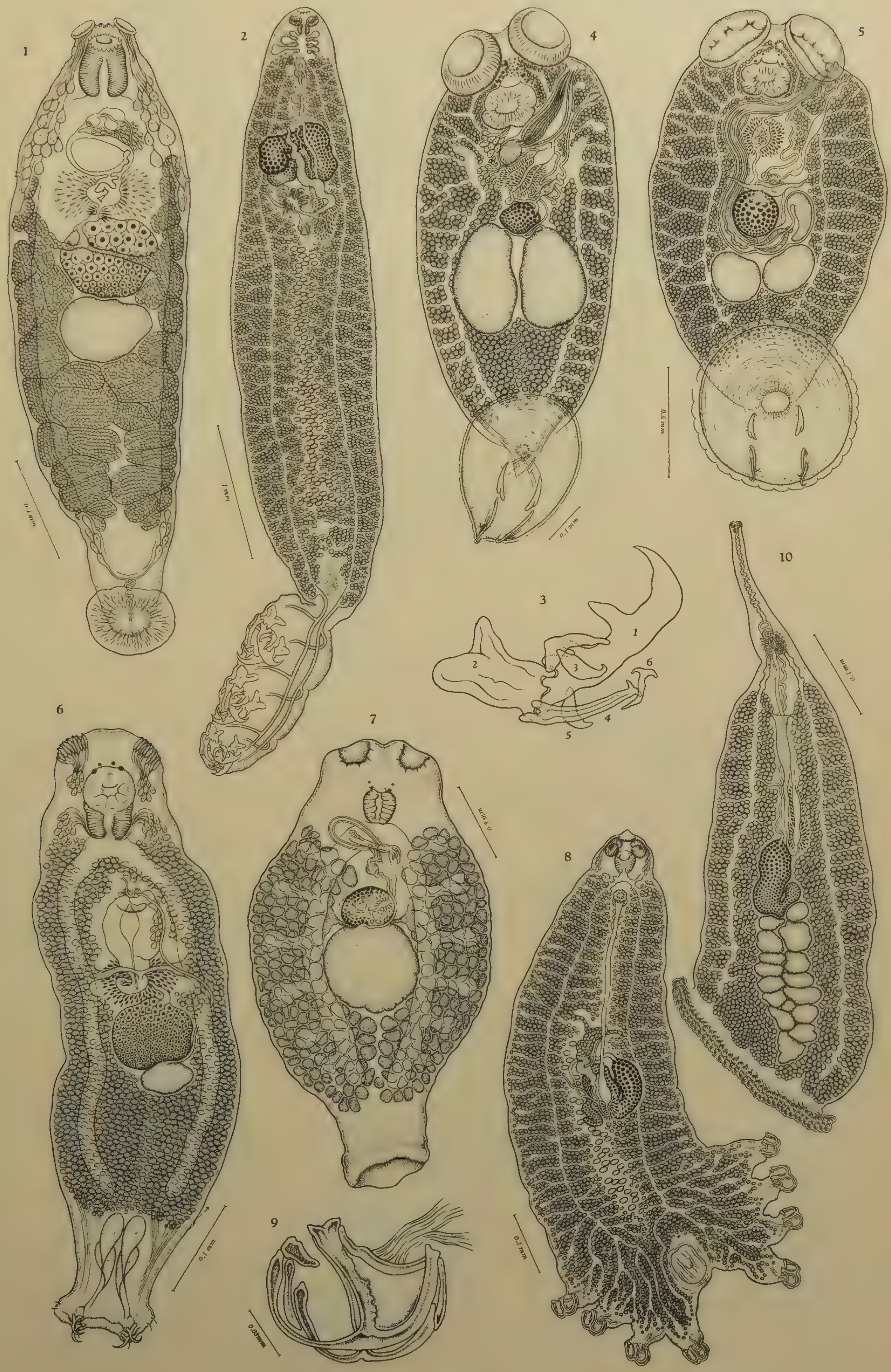
PLATE III

Fig. 1. *Udonella caligorum* JOHNSTON, 1835, ventral view.
Fig. 2. *Megaloncus arelisci* n. g., n. sp., body proper in ventral view, opisthohaptor in dorsolateral view.
Fig. 3. Anchor complex of opisthohaptor of *Megaloncus arelisci*, lateral view.
1) Principal claw. 2) Basal piece. 3) Saddle of principal claw. 4) Bar. 5) Saddle of bar. 6) Accessory piece of bar.
Fig. 4. *Benedeniella congeri* n. g., n. sp., ventral view.
Fig. 5. *Metabenedeniella hoplognathi* n. g., n. sp., ventral view.
Fig. 6. *Pseudamphibdella paralichthydis* n. g., n. sp., ventral view.
Fig. 7. *Pseudomicrobothrium spari* n. g., n. sp., ventral view.
Fig. 8. *Osphyobothrus parapercis* n. g., n. sp., ventral view.
Fig. 9. Skeleton of clamp of *Osphyobothrus parapercis*.
Fig. 10. *Axine* (*Axinoides*) *sebastisci* n. sp., ventral view.

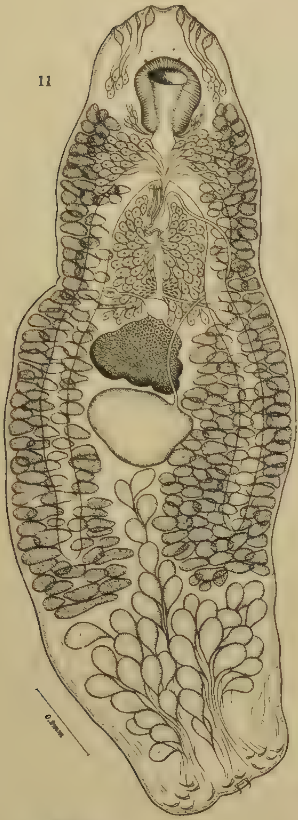
PLATE IV

Fig. 11. *Microncotrema lateolabracis* n. g., n. sp., ventral view.
Fig. 12. *Squaloncocotyle laymani* n. sp., dorsal view.
Fig. 13. *Microcotyle sebastisci* n. sp., ventral view.
Fig. 14. *Murraytrematoides ditrematis* n. g., n. sp., ventral view.
Fig. 15. *Microcotyle gimpo* n. sp., ventral view.
Fig. 16. *Geneticoenteron lateolabracis* n. g., n. sp., ventral view.
Fig. 17. *Pseudomurraytrema spari* n. g., n. sp., ventral view.
Fig. 18. *Pseudorhabdosynochus epinepheli* n. g., n. sp., dorsal view.

PLATE III



S. Yamaguti: Studies on the Helminth Fauna of Japan, 53.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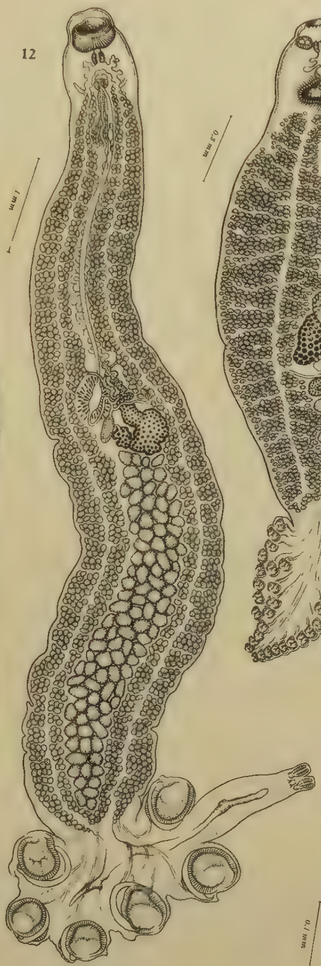
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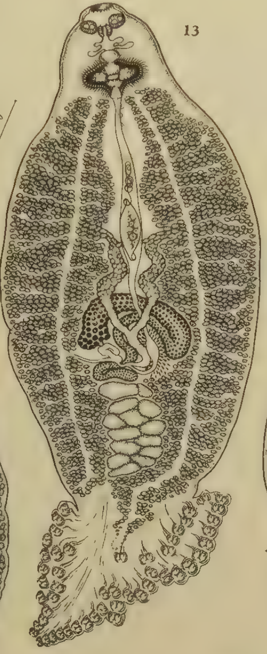
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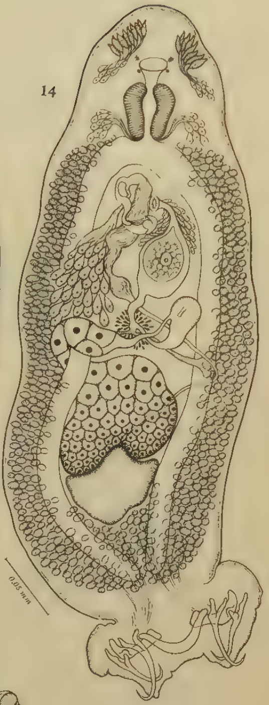
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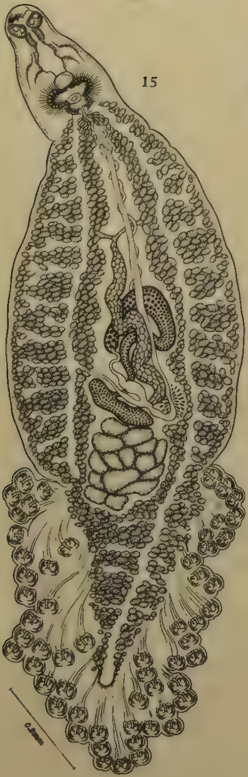
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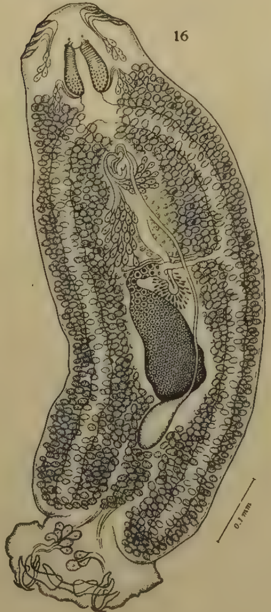
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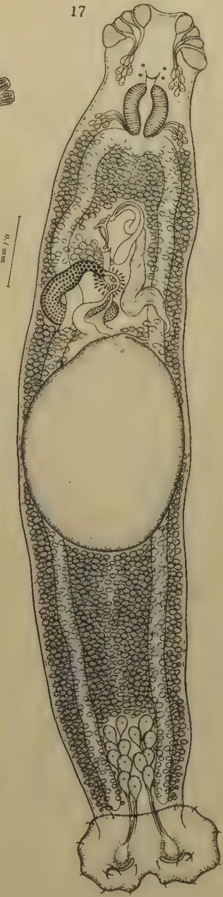
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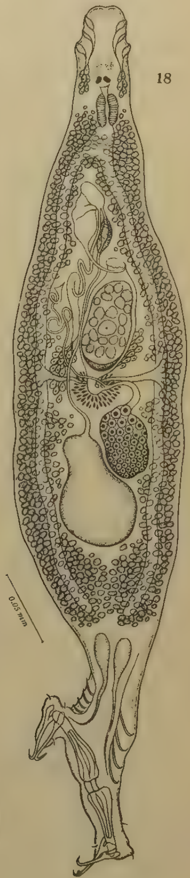
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S. YAMAGUTI: STUDIES ON THE HELMINTH FAUNA OF JAPAN. 53.

ON SOME OCTOCORALS FROM DEEP WATERS OF PROV. TOSA, SIKOKU[1]

Huzio UTINOMI

Seto Marine Biological Laboratory, Sirahama

With Plates V–VI and 8 Text-figures

This paper represents one of a series describing the regional Octocorallian fauna along the coasts of Japan and deals only with the material collected chiefly from deep waters of Tosa Bay and its environs, Sikoku, southern Japan.

The material dealt with comes from several sources. The majority was obtained from bottom samples gathered in 1953 by bull trawlers for offshore bottom-fishes, and kindly submitted to me for examination by Prof. T. KAMOHARA of Kôchi University to whom I wish to express my indebtedness. The details of localities, etc. are thus not clearly available. A part (*Melithaea ocracea*) was collected by Mr. M. HORI of the Osaka Municipal Museum of Natural History and is lodged in that Museum.

In addition, I have had an opportunity of examining the late Dr. Kumao KINOSHITA's collection of gorgonaceans from Tosa Bay which is now contained in the collections of the Zoological Institute, Tokyo University. My thanks are due to Dr. Itiro TOMIYAMA of Misaki Marine Biological Station of Tokyo University for enabling me to examine specimens among KINOSHITA's collection and certain other specimens for comparison. My thanks are also due to Mr. Frederick M. BAYER, associate curator of the U. S. National Museum, Washington, for help and useful informations concerning the identification of Japanese telestids.

A list of the species collected from Tosa Bay is given below:

Telestacea

Fam. Telestidae

1. *Telesto tubulosa* KINOSHITA
2. *Paratelesto rosea* (KINOSHITA), comb. nov.
3. *Paratelesto kinoshitai* n. gen. et n. sp.

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[1] Contributions from the Seto Marine Biological Laboratory, No. 318.

Publ. Seto Mar. Biol. Lab., VII (1), 1958. (Article 4)

Alcyonacea

Fam. Xeniidae

4. *Anthelia tosana* n. sp.

Fam. Alcyoniidae

5. *Bellonella dofleini* (KÜKENTHAL)
6. *B. macrospina* (KÜKENTHAL)
7. *B. sibogae* UTINOMI

Fam. Nephtheidae

8. *Dendronephthya querciformis* KÜKENTHAL

Fam. Nidaliidae

9. *Siphonogorgia dipsacea* (WRIGHT et STUDER)

Gorgonacea

Fam. Melithaeidae

10. *Melithaea ocracea* (LINNAEUS)

Fam. Parisididae

11. *Parisis minor* WRIGHT et STUDER

Fam. Acanthogorgiidae

12. *Acanthogorgia multispina* KÜKENTHAL et GORZAWSKY

Fam. Paramuriceidae

13. *Muriceides collaris* NUTTING
14. *Menella indica* GRAY

Fam. Ellisellidae

15. *Ellisella rubra* (WRIGHT et STUDER)

Fam. Isididae

16. *Acanella microspiculata* AURIVILLIUS

Pennatulacea

Fam. Kophobelemnidae

17. *Kophobelemnon stelliferum* (O. F. MÜLLER)

Fam. Virgulariidae

18. *Scytalium sprendens* (THOMSON et HENDERSON)

Fam. Pennatulidae

19. *Pennatula murrayi* KÖLLIKER

TELESTACEA

Fam. Telestidae MILNE EDWARDS et HAIME

Genus *Telesto* LAMOUROUX

Telesto tubulosa KINOSHITA

(Fig. 1 ; Pl. V, fig. 1)

Telesto tubulosa KINOSHITA, 1909, p. 114, pl. 3, figs. 1–6 ; KÜKENTHAL, 1913, pp. 233–234.
Clavularia japonica NUTTING, 1912, p. 13, pl. 1, figs. 1–1a ; pl. 17, fig. 2.

Material. 8 specimens in fragments. Tosa Bay. T. KAMOHARA coll. 1953.

Largest one of specimens is a bent, unbranched stem, lacking basal stolon, about 6 cm long. The main stem, namely the greatly elongated anthostelar part of the axial polyp, about 1.5 mm in diameter all throughout, bears 12 widely separated lateral polyps, arising at angle of about 40°–45°.

The axial polyp at its extremity and all lateral polyps form a thin-walled, cylindrical calyx, about 3–7 mm long (mostly 5 mm long in the middle of the stem) and are provided with 8 distinct longitudinal ribs which become obscure toward the main stem. Their diameter is approximately 1–1.2 mm. The main stem is light yellowish in color, while the calycular wall of lateral polyps is paler and even brownish white.

The anthocodial armature and the spiculation of body walls agree well with the original description given by KINOSHITA (1909).

Spicules in the outer layer of the body wall are mostly tuberculate capstans with a median waist, about 0.15 mm long and 0.05–0.08 mm wide, or barrels with lumpy warts. The inner layer is filled with irregular formed rods, interlocking with one another by their processes, occasionally fused together. They are 0.1–0.14 mm long and 0.05–0.08 mm wide. In the mesenteries there are somewhat curved, flattened spicules smaller than the anthocodial spicules, about 0.09–0.12 mm long. Anthocodial spicules are flattened spindles with jaggy margin, about 0.12–0.26 mm long. On the dorsal surface of tentacles, short lumpy rods, about 0.1–0.16 mm long and 0.018–0.035 mm wide, are closely placed longitudinally.

Inasmuch as I have examined, this species is usually not covered by any sponges, unlike most of other telestids.

Type locality. Kagosima Bay, Prov. Satuma, southern Kyusyu, 70 fathoms[1].

Other occurrence in Japan. Nomo-zaki, west of Ryusyu, 71 fathoms, Ose-zaki Light, Gotô Islands, west of Kyusyu, 95–106 fathoms (all from the "Albatross" Exploring survey around Japan, NUTTING 1912); southwest of Kyusyu (between 28°10′ N., 126°02′ E. and 28°20′ N., 126°11′ E.), 64 fathoms, N. YANAGI coll., June 22, 1913[2] (together with *Pseudocladoconus hicksoni*); off Enosima, Sagami Bay, 150 m, February 3, 1956[3].

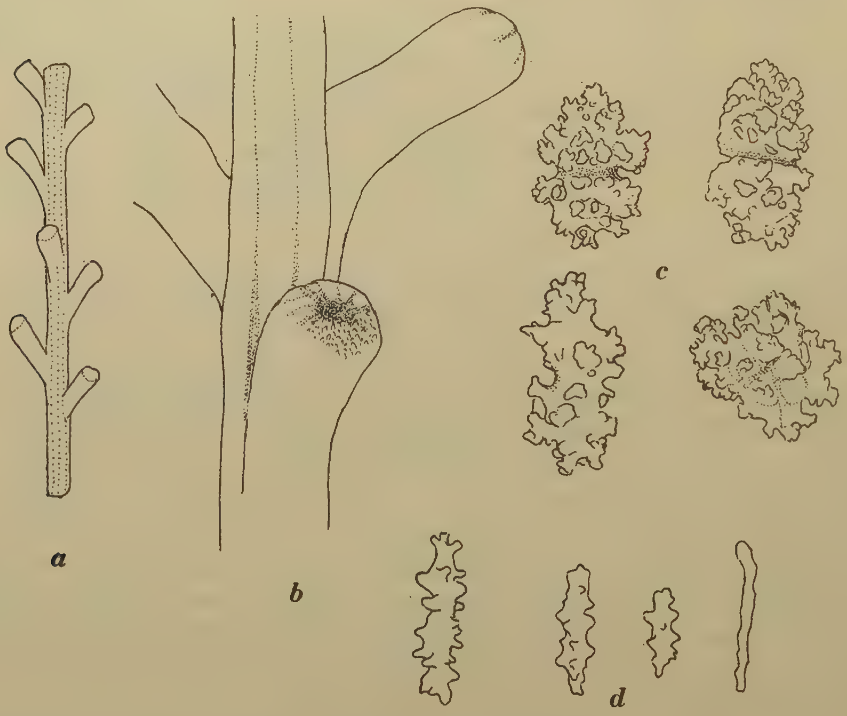

Fig. 1. *Telesto tubulosa* KINOSHITA.

a, Part of a colony; *b*, detail of anthostelar part of axial polyp, with three lateral polyps; *c*, spicules from outer layer of body wall; *d*, spicules from inner layer of body wall. [*a*, ×1.3; *b*, ×10; *c–d*, ×150.]

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[1] Unfortunately, I and Dr. TOMIYAMA also were unable to locate KINOSHITA's type specimen of *Telesto tubulosa* as well as other telestids among the collections of the Zoological Institute of Tokyo University.

[2] The material is in the Zoological Institute, Tokyo University.

[3] The material is in the Biological Laboratory of the Imperial Household.

Remarks. Clavularia japonica NUTTING (1912) the type of which I have re-examined myself through the courtesy of Mr. BAYER of the U. S. National Museum, is nothing but a telestid undoubtedly referable to this species. In fact, all the localities at which the U. S. Fisheries steamer "Albatross" collected "*Clavularia japonica*" are not far distant from the type locality of this species, as cited above.

Genus *Paratelesto* gen. nov.

Diagnosis. Low arborescent colonies of the Telestacea having some characters connecting between the genera *Telesto* and *Coelogorgia*. From a broadened base, not forming creeping stolons, profusely branched stem arise; stem and branches formed by axial polyps of high orders bear many small-sized lateral polyps in spirals; body wall of axial polyps greatly thickened by mesogloea perforated with solenia arranged in rings concentrically around a large coelenteric cavity of axial polyps, open to base; calycular part of axial polyps small, truncate-conical in form like lateral polyps and provided with 8 longitudinal ribs composing of double rows of coarsely warted blunt rods; longitudinal grooves indistinct on body walls of anthostelar part of axial polyps.

Genotype: *Telesto rosea* KINOSHITA, 1909.

Paratelesto rosea (KINOSHITA) comb. nov.

(Fig. 2; Pl. V, figs. 2–4)

Telesto rosea KINOSHITA, 1909, p. 119; KÜKENTHAL, 1913, p. 234 (listed only).
Telesto rosea (partim) KINOSHITA, 1910, p. 209.

Material. Fragments without base. Coral ground off Kasiwazima, Prov. Tosa, 80 fathoms. K. KINOSHITA coll. June 1909. Preserved in the Zoological Institute, Tokyo University.

One incomplete specimen, largest of fragments, is flabellate in form[1], measuring 5×3 cm.

The stem shows 1.5 mm in diameter, and bears three branches. The colony is uniformly bright red in color, but thinnly covered by a delicate silicious sponge, through which the lateral polyps protrude.

The lateral polyps are arranged alternate-spirally on all stem and branches at intervals of about 1–2 mm, usually arising at an acute angle. They are small in size as in the distalmost end of the axial polyps.

The calycular part of all polyps is truncate-conical to tubular in shape, measuring 1–3 mm high and about 1 mm in diameter, and more or less distinctly grooved longitudinally. At distal end the spicules of the 8 longitudinal ribs terminate to converging points which bend inwards to cover the retracted anthocodia.

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[1] In complete colonies from Prov. Kii, however, the branching is not always flabellate, but rather bushy in form.

The anthocodial spiculation shows the typical *en chevron* arrangement as usual in other telestids. The point spicules are apparently lesser in number and transverse collarets are not formed. They are somewhat flattened spindles, measuring 0.25×0.035 mm and 0.3×0.026 mm. On the aboral side of tentacles, smooth rodlets, about 0.1×0.035 mm, are longitudinally placed becoming in a single row towards the tip. Pinnules have each a curved slender rodlet.

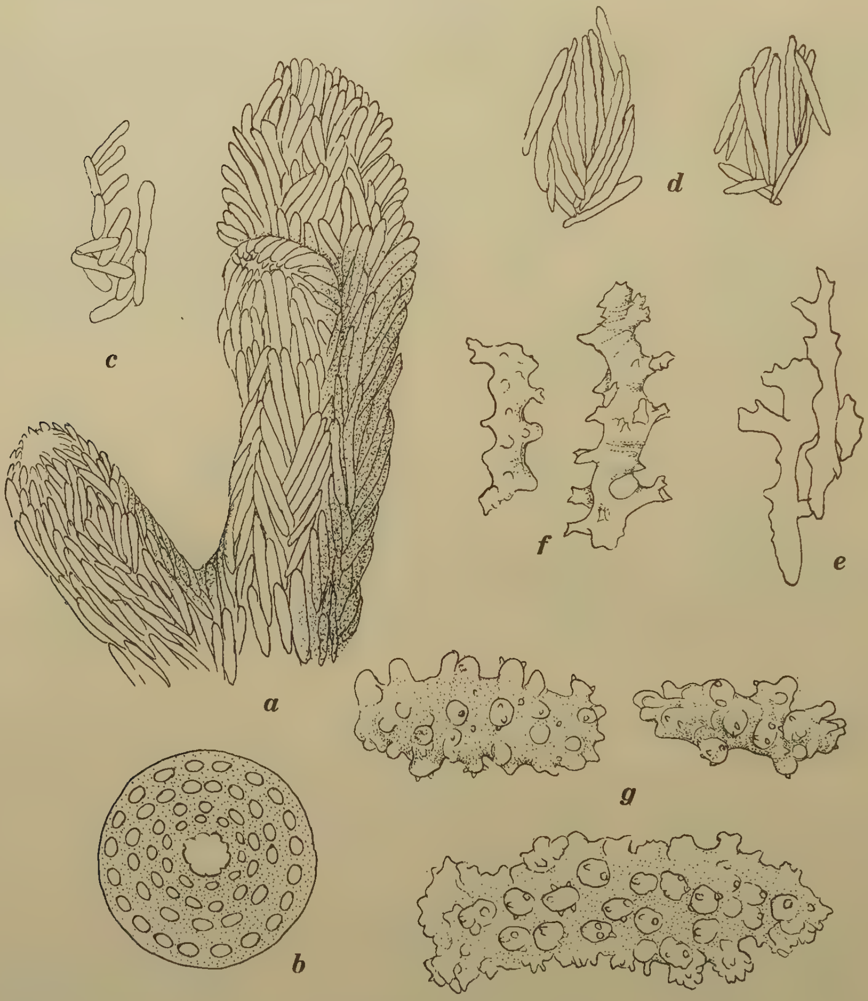

Fig. 2. *Paratelesto rosea* (KINOSHITA).

a, Distal part of axial polyp, with two lateral polyps; *b*, cross section of axial polyp near base, diagrammatic; *c*, tentacle spicules *in situ*; *d*, anthocodial spicules arranged *en chevron*; *e*, lobate spicules of inner layers interlocking together; *f*, inner spicules with forked warts; *g*, outer spicules with simple or tuberculated warts.

〔*a–d*, ×80; *e–g*, ×130.〕

The body wall is extremely thickened and spiculiferous, so that the whole colony is rigid and brittle. On making a cross section through one of the branches, it may be seen to be perforated by a number of solenia arranged in rings concentrically around a central coelenteric cavity of the axial polyp which is open to base, not filled with any spiculiferous "intrusion tissue" as found in species of *Telestula.* Towards the base, the central coelenteric cavity becomes narrower and the rings of surrounding solenia increase in number up to 6 according to the diameter of branches and stem.

As mentioned above, the body wall consists of two layers. Spicules of the outer layer are for the most part coarsely warted blunt rods with simply rounded or slightly jagged warts. They measure: 0.26×0.09 mm, 0.3×0.09 mm and 0.32×0.11 mm. Near the ends of calyces they often assume somewhat clavate form, broader at its distal end. In the inner layer perforated by a number of solenia, there are also scarcely warted rods with warts forked at end and irregularly branched flat rods, both peculiar to *Telesto*, measuring approximately 0.17×0.07 mm, 0.23×0.07 mm, 0.26×0.09 mm and 0.3×0.26 mm. These inner spicules are in part longitudinally disposed, in part towards the periphery. They do not, however, fuse together, but are only interlocked with one another by their processes.

Remarks. This species has been originally described without any illustrations by KINOSHITA (1909), based on a single specimen from off Miyake-zima, south of Prov. Izu. Afterwards he (1910, p. 209) made some remarks about the material from Prov. Tosa. The present specimen on which the above description is based is probably one of the specimens he identified with *Telesto rosea,* the type specimen of which is lost according to Dr. TOMIYAMA (personal communication).

This species is fairly common around the southern coasts of Kii Peninsula. So in describing I have compared with a number of specimens so far collected there.

The differences of this species from many ordinary species of *Telesto* have already been recognized by KINOSHITA (1910), particularly in the multiperforated mesogloeal structure of the body wall, which is not comparable with that of *Telesto rupicola, riisei, multiflora, smithi,* etc., as figured by LAACKMANN (1909, Taf. 7–8).

Paratelesto kinoshitai sp. nov.

(Fig. 3; Pl. V, fig. 5)

Telesto rosea (partim) KINOSHITA, 1910, p. 209.

Material. Two fragments (labelled as "*Telesto* 4 and 5"). Coral ground off Kasiwazima, Prov. Tosa. K. KINOSHITA coll. June 1909. Preserved in the Zoological Institute, Tokyo University.

Of two fragments, the larger one (Pl. V, fig. 5 on the right hand) is here designated as holotype. It, although incomplete, is scantily branched, consisting of a main stem, about 6 cm long, and one branch and three sub-branches, spreading in one plane. All branches issue at nearly right angles. The distal part of the main stem is missing. The base is only slightly flattened, but not stoloniferous. Near the base where a single barnacle (*Balanus krügeri* PILSBRY) is attached, the main stem is about 6 mm in diameter and the proximal part of the primary branch giving off from the lower part of the stem is 4 mm in diameter. Further upwards, the stem and

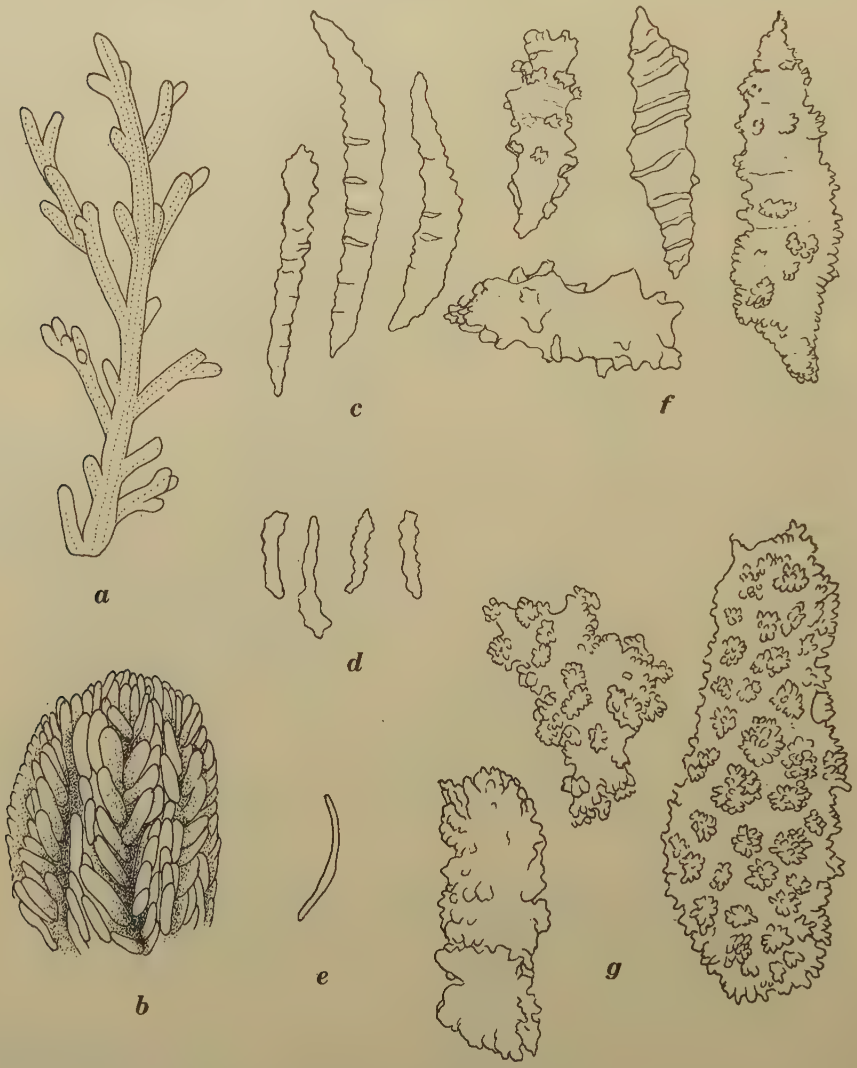

Fig. 3. *Paratelesto kinoshitai* n. gen. et n. sp.

a, Part of colony ; *b*, detail of distal part of polyp ; *c*, anthocodial spicules ; *d*, tentacle spicules ; *e*, pinnular spicule ; *f*, spicules from inner layers of body wall ; *g*, spicules from outer layer of body wall. 〔*a*, ×12 ; *b*, ×20 ; *f–g*, ×130 ; *c–e*, ×150.〕

branches only slightly taper and bear on all sides short cylindrical lateral polyps rather irregularly at intervals of about 2 mm. These lateral polyps are rather erect in the lower part, but become to be slightly bent upwards in the narrower branches.

The calycular part of the axial polyps does not differ much from all lateral polyps in either form or size. They are all white, while the stem and branches proper are pink colored, except for one sub-branch only distally.

Another piece (Fig. 3, *a* and Pl. V, fig. 5, on the left hand), which is a terminal part of a branch from the same or different colony, measuring about 25 mm in length, bears about 6 short sub-branches and a few single lateral polyps, issuing at acute angles. This is, however, uniformly pink in color.

Many of the lateral polyps, as large as the calycular part of the axial polyps, are short tubulo-conic in shape, about 1.5–3.0 mm long and about 1.0 mm in diameter, with eight narrow but deep, longitudinal grooves separated by broad ribs continuing downwards in narrow branches. Each longitudinal rib is composed of a double row of spicules and the components of each row overlap so that three or more abreast at any one place. Towards the lower anthostelar part of the branches and main stem, wider than 2.5 mm in diameter, spicules are irregularly arranged all over the surface, not forming any longitudinal rows or ribs.

The body wall consists of two layers as in the preceding *rosea.* Spicules of the outer layer are mostly very large, blunt rods covered with multi-tuberculated warts, measuring 0.35 × 0.14 mm, 0.4 × 0.17 mm and 0.45 × 0.16 mm. More irregular forms also may occur.

In the inner layer there are similar rods or spindles, or irregular forms with multi-tuberculated warts and also coarsely or irregularly warted rods or spindles, mostly smaller than the above. They measure 0.18 × 0.12 mm, 0.21 × 0.09 mm, 0.32 × 0.07 mm, 0.36 × 0.12 mm, and 0.36 × 0.07 mm. These inner spicules are closely but separably packed together under the outer layer in the calycular part, and in the coenenchyme surrounding the central coelenteric cavity which penetrates down to the base of the stem.

The mesogloeal interior is perforated by many solenia in rings, as noticed in the preceding species.

The retractile anthocodia is comparatively small and shows the spiculation similar to that of the preceding *rosea.* The anthocodial spicules are spindles with a few transverse ribs corrugated in rings, measuring 0.18 × 0.036 mm and 0.21 × 0.032 mm. Tentacle spicules are flat rods with jagged margins, measuring 0.09 × 0.02 mm and 0.1 × 0.036 mm. Pinnules have each a curved slender rodlet, about 0.09 × 0.005 mm.

All of these spicules are pink or white.

Remarks. This specimen differs from the type species *Paratelesto rosea* in the form of branching, the spiculation and the coloration of the colony.

ALCYONACEA

Fam. Xeniidae VERRILL

Genus *Anthelia* LAMARCK

According to the generally accepted concept of classification, the genus *Anthelia* (genotype: *A. glauca* SAVIGNY) is admittedly a member of the Xeniidae, but regrettably it has been frequently confused with the stoloniferan genus *Clavularia* (genotype: *C. viridis* Q. et G.), for example as has been done by most of the Scandinavian workers as well as HICKSON (1894, 1930). The definition of this genus has been given adequately by GOHAR (1940 a, b).

In this genus, the anthocodia is not separable from the anthostele regarding the distribution and size of spicules, and the former is not retractile into the latter, as in the genus *Xenia*. The base from which the polyps arise, is invariably membranous, not forming a network of stolons. The spicules are mostly minute, flattened rodlets with rugged or toothed margins, instead of wineglass-shaped or biscuit-shaped smooth discs as in the genus *Xenia* and allies. They are all evenly scattered on the periphery and not confined to either the anthocodia or the anthostele. However, there are often species lacking spicules entirely as in the case of *Xenia* (ROXAS, 1933). In these respects, *Sarcothelia* only known from Hawaii (type: *S. edmondsoni* VERRILL, 1928) should be transferred to *Anthelia*.

From the neighboring seas three species are hitherto known: *A. lineata*1) STIMPSON (a doubtful species probably identical with or nearest to *A. longissima* (MAY)), *A. japonica* KÜKENTHAL (1906) and *A. formosana* UTINOMI (1950). The former two species are non-spiculated form, while the last-named one with spicules. To these I here add a new spiculated species from Tosa Bay.

Anthelia tosana sp. nov.

(Fig. 4; Pl. VI, fig. 6)

Material. A membranous colony from Tosa Bay. T. KAMOHARA coll. Details of locality and date of collecting unrecorded. Holotype is preserved in the Seto Marine Biological Laboratory, as designated S. M. B. L. Type 167. A part of the same colony is deposited in the Zoological Institute, Kyoto University.

From a very thin basal membrane, about 0.5 mm thick at margins, numerous unconstricted polyps arise with their bases close together. The colony is entirely dirty white in alcohol.

Fully grown polyps are about 10–12 mm in height, excluding the tentacles and about 2 mm in diameter at their bases.

The surface of the anthostele is apparently smooth, without longitudinal grooves

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1) Redescribed by VERRILL (1865).

along the mesenteries. At the top there is a papilla-like hypostome, about 0.8 mm high.

Tentacles are generally short, up to 4 mm long and 0.6 mm wide at their bases. In younger polyps, short, finger-like pinnules (6–12) are arranged in one row on either side, but in fully grown polyps, in two rows, counting about 13 or 14 in one row. Pinnules are longest in the middle, about 0.7 mm long and 0.03 mm wide, becoming shorter towards the distal and proximal parts, down to 0.1 mm long.

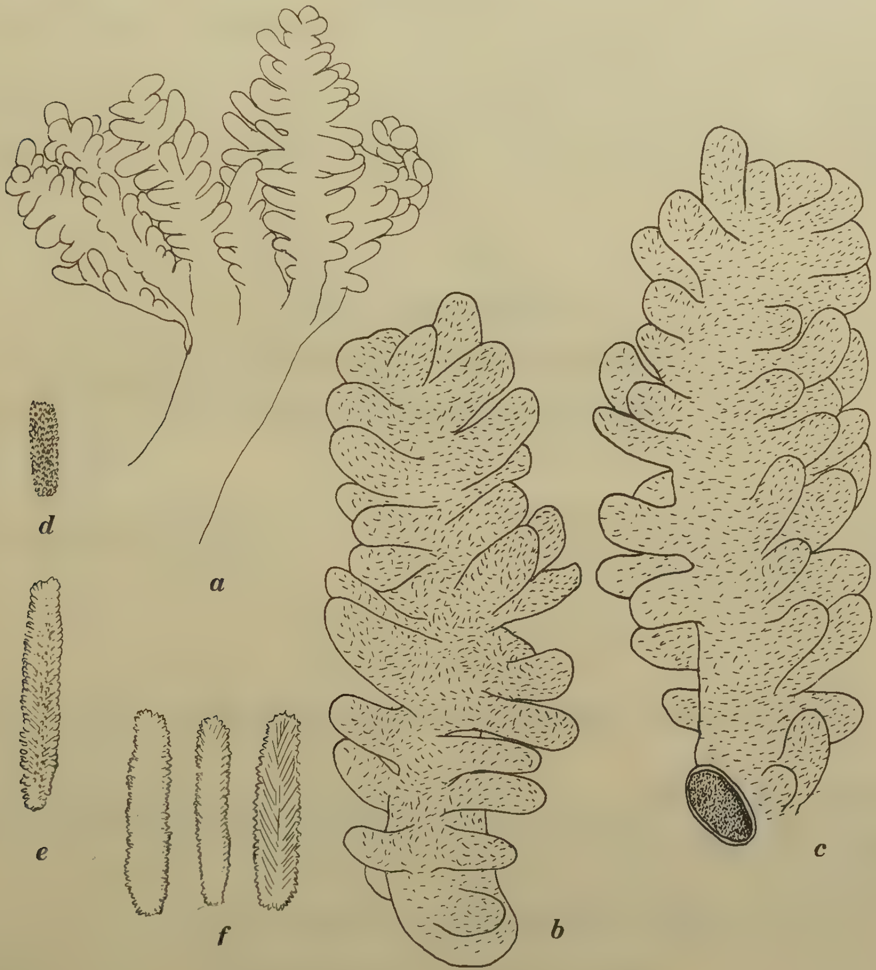

Fig. 4. *Anthelia tosana* n. sp.

a, Distal part of polyp; *b*, tentacle, aboral side; *c*, tentacle, adoral side; *d*, spicule from tentacles; *e*, spicule from anthostele; *f*, spicules from basal membrane.
〔*a*, ×10; *b–c*, ×27; *d–f*, ×420.〕

Spicules are more or less evenly scattered all over the surface and not crowded at any particular parts. They are all minute flattened rodlets, usually truncated at both ends and their flattened surface may look slightly roughened. Careful examination by high-power microscope reveals, however, that their minor structure and size are not always homogeneous. On the tentacles and pinnules they are smallest, with minutely granular surface, 0.04–0.05 mm long and 0.012–0.014 mm wide. (Fig. 4 *d*). On the anthostelar part, they are more elongate discs with radially striated or slightly granulated surface and jagged margins, about 0.05–0.07 mm long and 0.01–0.014 mm wide (Fig. 4 *e*). Spicules on the basal membrane are a little wider, elongate rhombic discs with jagged margins, often radially striated on flattened faces, about 0.05–0.07 mm long and 0.01–0.014 mm wide (Fig. 4 *f*).

Remarks. In every respect, this specimen from Tosa Bay seems to be different specifically from all the known species of this genus mentioned in a key given by ROXAS (1933, p. 62) and also from *A. formosana* UTINOMI (1950) from Garanbi, Formosa.

Fam. Alcyoniidae LAMOUROUX

Genus *Bellonella* GRAY

Bellonella dofleini (KÜKENTHAL)

Bellonella macrospina (KÜKENTHAL)

Bellonella sibogae UTINOMI

These three species of *Bellonella* have already been described in detail based largely on materials from Tosa Bay, presented by Dr. KAMOHARA (UTINOMI, 1957, p. 161, p. 162 and p. 164).

Fam. Nephtheidae GRAY

Dendronephthya querciformis KÜKENTHAL

(Pl. VI, fig. 7)

This species also has already been described, based on three complete colonies from Tosa Bay, presented by Dr. KAMOHARA (UTINOMI, 1954, p. 328).

Fam. Nidaliidae GRAY (UTINOMI emended)

(=Siphonogorgiidae KÖLLIKER auct.)

Siphonogorgia dipsacea (WRIGHT et STUDER)

Chironephthya dipsacea WRIGHT et STUDER, 1889, p. 251, pl. 37, figs. 1, 1 a.
Siphonogorgia dipsacea KÜKENTHAL, 1906, p. 76, 82, pl. 3, fig. 19.

Material. 2 colonies, 3.5 cm long and 4.0 cm long. Tosa Bay. T. KAMOHARA coll. 1953.

GORGONACEA

Subord. Scleraxonia

Fam. Melithaeidae GRAY

Melithaea ocracea (LINNAEUS)

(Pl. VI, fig. 8)

Melithaea ochracea UTINOMI, 1956, p. 236, fig. 8, *a–k* (synonymy).

Material. 8 colonies. Okinosima, Prov. Tosa, 10–50 m. H. HORI coll. July 23, 1952. Preserved in the Osaka Municipal Museum of Natural History.

This large-sized melithaeid is well known from the tropical region of the West-Pacific Ocean, but so far not recorded from Japanese waters. However, I have already confirmed its occurrence around the coasts of Kii Peninsula, where it has often been stranded ashore after storm.

According to Mr. HORI's field note, this species occur abundantly on the rocky cliff of Okinosima at a depth of 10–50 m, the habitat being deeper than that of the small-sized species *M. flabellifera* (KÜKENTHAL) which is more common in warm waters of southern Japan from Sagami Bay south to Kyusyu.

The largest one of specimens he has collected attains about 50 cm in height and 30 cm in width.

Fam. Parisididae AURIVILLIUS

Parisis minor WRIGHT et STUDER

(Fig. 5; Pl. VI, fig. 9)

Parisis minor WRIGHT et STUDER, 1889, p. 184, pl. 41, fig. 6; KÜKENTHAL, 1924, p. 83; AURIVILLIUS, 1931, p. 30, fig. 5.

Material. Fragments. Kasiwazima. T. KINOSHITA coll. June 1909. Preserved in the Zoological Institute, Tokyo University.

One of larger fragments consists of a stem and a primary branch, broken at both ends. It is about 7 cm in total height and the stem shows about 2 cm in diameter in the lower part. When complete in life, the colony may spread in one plane. The specimen is wholly white.

The polyps, occurred biserially in the branching plane, at intervals of about 1–3 mm, are short, truncate-conical in shape and measure about 0.5–1.0 mm high and 0.7–0.8 mm wide at base.

The coenenchymal spicules covered on the stem and polyps are all tuberculate plates, more or less larger in the outer layer (Fig. 5 *e*) than in the inner layer (Fig. 5 *d*); when smaller in size, they often may take a flattened rod or capstan-like form. Measurements in mm: 0.26×0.18, 0.18×0.14, 0.18×0.09, 0.1×0.07, 0.07×0.05 and 0.07×0.03.

The axis of the stem and branches, including the internode and node together, is deeply furrowed longitudinally all throughout. The calcareous internode, entirely white, is approximately 2.5 mm long, while the horny node, yellow in color, is approximately 0.5 mm long.

The longitudinal furrows surrounding the axis are not so numerous as in *P. fruticosa* VERRILL[1], as numbering only 14 in a branch with a diameter of 1 mm (*cf.* BAYER, 1956, p. 201, fig. 145, 2 *d*, 2 *e*). More interesting is that each one of the longitudinal furrows locating on the opposite sides is markedly widest. This widest furrows are clearly visible through the coenenchyme.

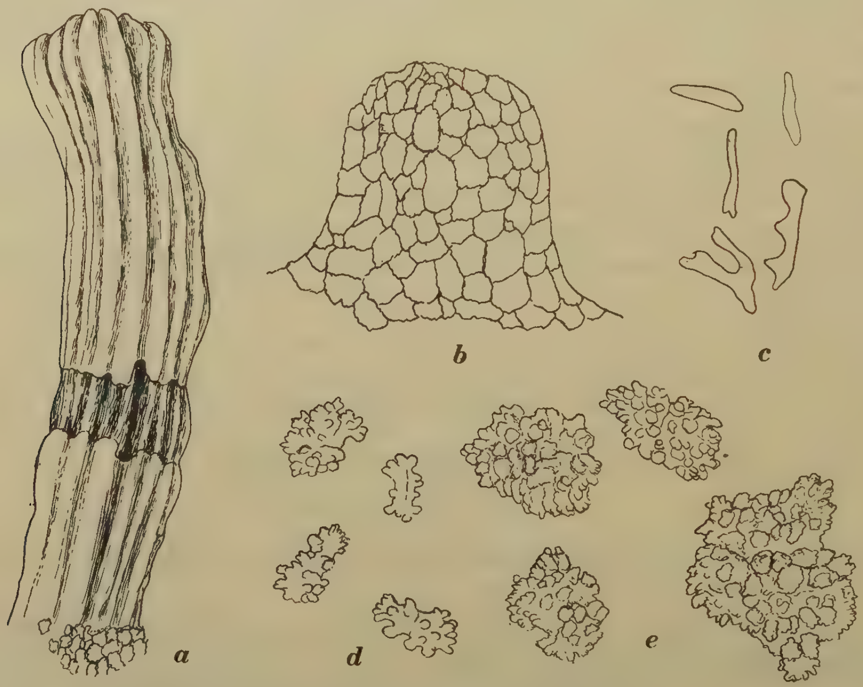

Fig. 5. *Parisis minor* WRIGHT et STUDER.

a, Distal part of axis, corticated; *b*, detail of polypal verruca; *c*, lobate rods of axial nodes; *d*, spicules from inner layer of coenenchyme; *e*, spicules from outer layer of coenenchyme. [*a*, ×18; *b*, ×66; *c–e*, ×128.]

The horny nodes are filled with lobate rods, about 0.05–0.09 mm long.

Distribution. Previously recorded from Hyalonema-ground (Dôketuba), Sagami Bay, 345 fathoms (WRIGHT et STUDER); Gotô Islands, west of Kyusyu, 160 m and east of Titizima (Chichijima), Bonin Islands, 80 fathoms (AURIVILLIUS).

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[1] This species is occasionally collected along the southern coast of Kii Peninsula.

Subord. Holaxonia

Fam. Acanthogorgiidae GRAY (KÜKENTHAL emend.)

Acanthogorgia multispina KÜKENTHAL et GORZAWSKY

(Fig. 6)

Acanthogorgia multispina KÜKENTHAL et GORZAWSKY, 1908, p. 61, Taf. 4, fig. 21; KÜKENTHAL, 1924, p. 246; STIASNY, 1947, p. 41, figs. E. F. (synonymy).

Material. Fragments. Tosa Bay. T. KAMOHARA coll. 1953.

The colony, broken into fragments, is loosely branched dichotomously but not in one plane. Branches arise perpendicularly. The axis is about 1 mm in diameter and brownish in color.

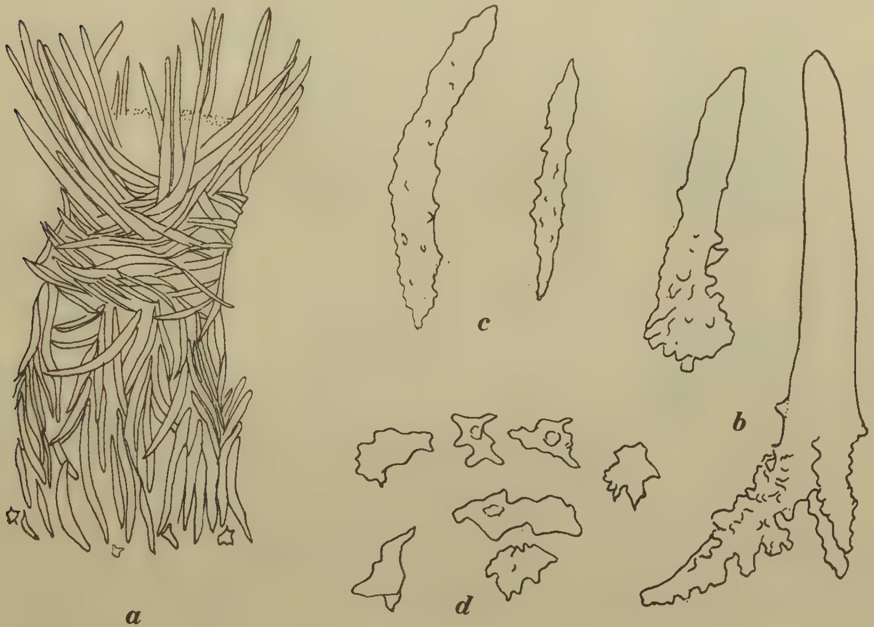

Fig. 6. *Acanthogorgia multispina* KÜKENTHAL et GORZAWSKY.
a, Detail of polyp; *b*, crown spicules; *c*, spindles of calyx wall; *d*, irregular bodies of polypal base. 〔*a*, ×33; *b–d*, ×97.〕

The spiculiferous polyps are mostly small, about 1–2 mm long, having large long-spined crown spicules at the top and minute irregular-shaped spicules, about 0.05×0.05 mm, at the base, which are peculiar to this species.

Distribution. Common around Japanese waters from Sagami Bay to Amoy, South China.

Fam. Paramuriceidae BAYER

(=Muriceidae STUDER auct.)

Muriceides collaris NUTTING

(Fig. 7)

Muriceides collaris NUTTING, 1910 a, p. 28, pl. 4, figs. 3 and 3 *a*; pl. 19, fig. 10; KÜKENTHAL, 1924, p. 164.

Material. One incomplete specimen. Tosa Bay. T. KAMOHARA coll. 1953.

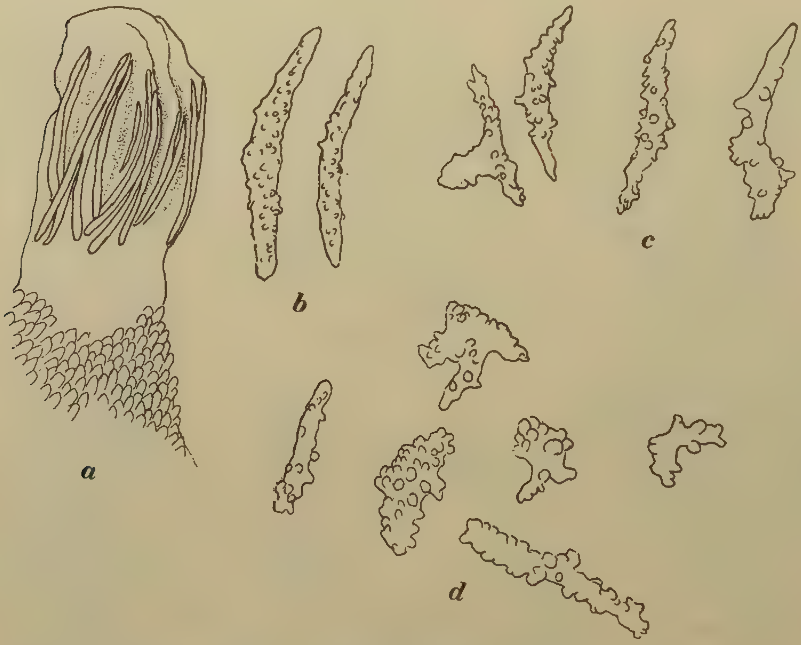

Fig. 7. *Muriceides collaris* NUTTING.

a, Polyp, extended; *b*, anthocodial spicules; *c*, spicules from branch cortex; *d*, spicules from stem cortex. 〔*a*, ×45; *b*–*d*, ×80.〕

A single specimen, lacking the distal part of the stem, is about 17 cm in total height and very loosely branched in one plane. The colony is dirty white in alcohol and flexible.

From the main stem with the membranous basal expansion, two lateral branches are given off perpendicularly to the stem and a few secondary and tertiary branches are again given off from the one primary branch. All of these branches turn upwards and bear prominent polyps rather spirally arranged at intervals of about 2 mm. The lower parts of the main stem and primary branches, however, have no polyps. The lower part of the stem is about 2 mm in diameter, covered by thick coenenchyme.

The polyps, including semi-extended operculum, are approximately 1.2 mm high and 0.8 mm wide. The operculum is highly projecting from the calycular margins at preserved state, and each point consists of long spindles disposed longitudinally, but not distinctly paired. These anthocodial spicules are slightly curved, tuberculate spindles, 0.39–0.44 mm long and 0.035 mm wide.

The coenenchymal spicules are all small tuberculate spindles and their derivatives, measuring about 0.24–0.33 mm long and 0.035 mm wide. They are imbricated on the calyx walls. In the lower part of the colony free from the calyces, spicules are generally smaller in size and more irregular in form.

Distribution. Previously known only from "Siboga" Station 253 (5°48.2′ S., 132°13′ E.) near Kei Islands, 304 m.

Menella indica GRAY

Menella indica GRAY, 1870, p. 407; NUTTING, 1912, p. 86; KÜKENTHAL, 1924, p. 184.

Material. An incomplete specimen, terminal part only. Tosa Bay. T. KAMOHARA coll. 1953.

The specimen is a very slender, flexible, unbranched, filiform stem, about 13 mm long, with a diameter of only 1 mm. It is dirty white all throughout. The calyces are distributed irregularly on all sides, but very low almost at levels of the general surface of spiculiferous coenenchyme, and their positions are only discriminable by the deeply sunken operculum of the completely retracted polyps below the surface.

Distribution. Previously recorded from off Ose-zaki Light, Gotô Islands, west of Kyusyu, 57 fathoms other than the type locality (Back Bay, Bombay, India).

Remarks. As criticized by STIASNY (1942), the coenenchymal spicules of this little-known *Menella* are of the *Echinomuricea*-type. But, I will discuss as to its validity as distinct genus in a paper dealing with the material from off the coasts of Kii Peninsula.

Fam. Ellisellidae GRAY (BAYER emended)

Ellisella rubra (WRIGHT et STUDER)

Scirpearella rubra WRIGHT et STUDER, 1889, p. 107, pl. 34, fig. 5; NUTTING, 1910 b, p. 24, pl. 6, figs. 1–5; NUTTING, 1912, p. 98.
Scirpearia rubra KÜKENTHAL, 1924, p. 372.

Material. A single young specimen, lacking the base, about 9 cm long. Tosa Bay. T. KAMOHARA coll. 1953.

The colony is unbranched, whip-like, with short calyces nearly 1.2 mm high arranged biserially. The color of the colony is rather salmon pink.

Distribution. Very common in warm waters of Japan, from Sagami Bay (type locality) far southwards.

Fam. Isididae LAMOUROUX (STUDER emended)

Acanella microspiculata AURIVILLIUS

(Fig. 8)

Acanella microspiculata AURIVILLIUS, 1930, p. 317, text-fig. 65, pl. 6, fig. 9.

Material. Fragments. Tosa Bay. T. KAMOHARA coll. 1953.

The colonies are radially branched, taking together a bushy form, with rootlike basal processes.

In a largest fragment the diameter of the main stem, just above the basal processes is about 2.5 mm. The axis is composed of alternating snowy white calcareous internodes and amber-colored transparent horny nodes. The internodes are generally longer than the nodes, and their length successively increase towards the branch terminals. For example, in one colony they measure from the base upwards in mm: 5, 2.8, 2, 2.5, 2, 2.5, 5, 5.5, (first branch), 6, 4.5, (second branch), 7, 7, ⋯ .

The surface of the axis is almost smooth. But when carefully examined, it reveals that it is finely furrowed longitudinally everywhere and that the tip of each internode is invariably pointed or peaked (Figs. 8, *e*, *f*).

The coenenchyme is thin, with scattered spicules, especially around the horny nodes. The polyps are arranged either tri- or biserially on the terminal branches, at intervals of about 2 mm.

Each polyp stands obliquely upwards to the axis and measures about 2 mm long and 0.5–1.0 mm wide, including slightly extended tentacles. It is covered by spicules of varying size arranged in lengthwise rows.

Spicules in the distal part of polyps are large, apparently smooth, rods with blunt ends, measuring 0.032 × 0.002 mm, 0.52 × 0.035 mm and 0.009 × 0.007 mm. (Fig. 8, *l*) Basal ones which are somewhat irregularly arranged are smaller, measuring 0.009 × 0.0017 mm to 0.017 × 0.0035 mm. (Fig. 8, *m*). In addition, there are much smaller inner spicules densely packed between the distalmost outer spicules; they are also rod-shaped but slightly warted, measuring about 0.12 × 0.032 mm and 0.05 × 0.01 mm (Fig. 8, *k*).

The tentacles are provided with dorsal and pinnular spicules, measuring respectively about 0.12 × 0.032 mm and 0.05 × 0.01 mm. (Figs. 8, *i*, *j*).

Spicules in the stem coenenchyme are also rod-shaped, with blunt ends and prickly surfaces, about 0.13–0.18 mm long and 0.035 mm wide.

Distribution. Previously known from Gotô Islands, 160 m and from off Bônomisaki, Kagosima Prefecture, both west of Kyusyu.

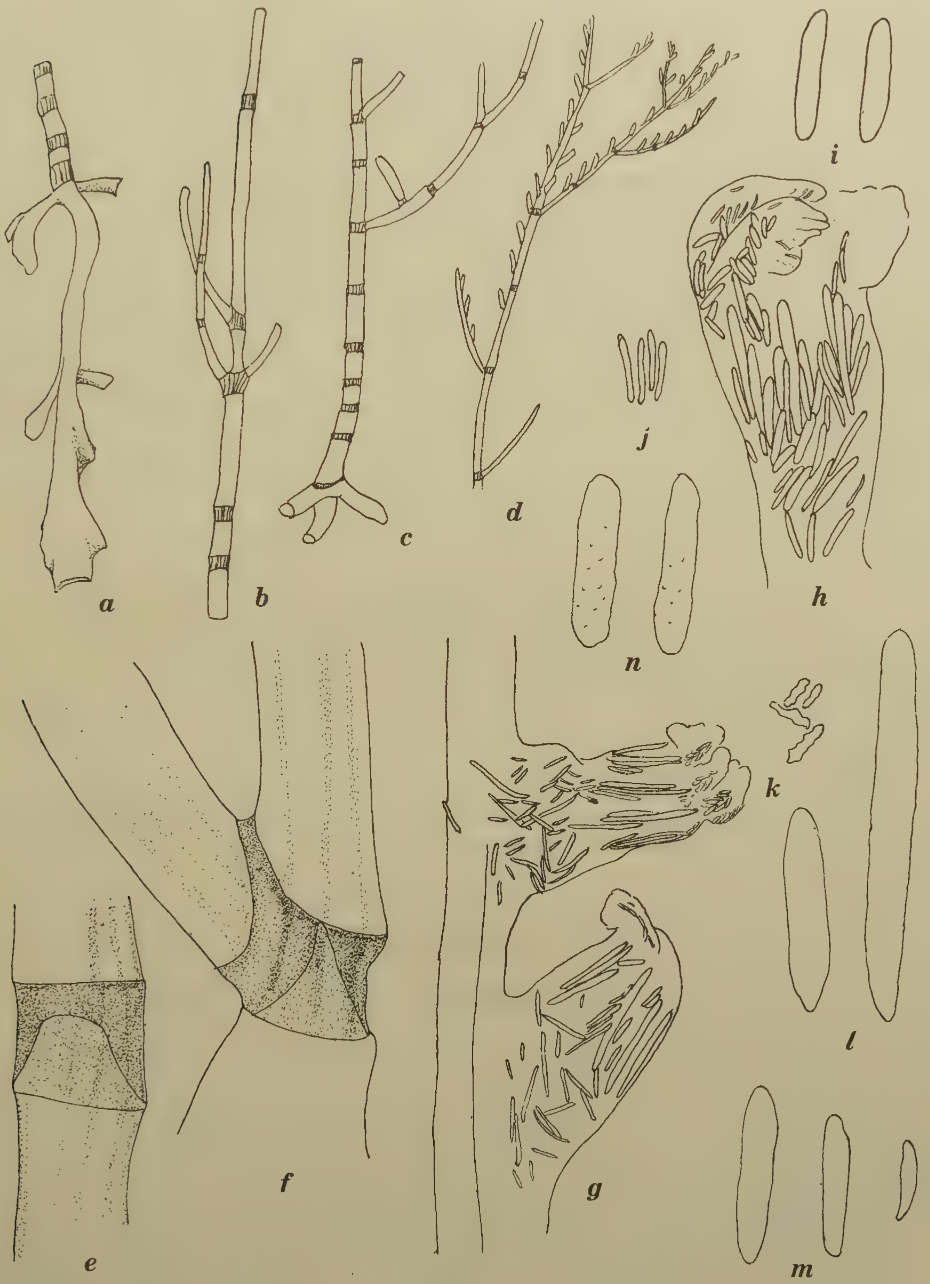

Fig. 8. *Acanella microspiculata* Aurivillius.

a–d, Fragments of colonies, showing root-like processes (*a*, *c*) and polypiferous branches (*d*); *e–f*, horny nodes of stem without (*e*) or with a branch (*f*); *g*, part of branch with two polyps; *h*, detail of polyp; *i*, tentacle spicules; *j*, pinnular spicules; *k*, inner spicules from distal part of polyp; *l*, polypal spicules, distal; *m*, polypal spicules, basal; *n*, coenenchymal spicules of stem. [*a–d*, ×2; *e–g*, ×18; *h*, ×33; *i–m*, ×150.]

PENNATULACEA

Fam. Kophobelemnidae GRAY

Kophobelemnon stelliferum (O. F. MÜLLER)

Kophobelemnon stelliferum BALSS, 1910, p. 25 (synonymy); THOMSON et RENNET, 1927, p. 122.

Material. One specimen. Tosa Bay. T. KAMOHARA coll. 1953.

A typical specimen of this widespread species was obtained. The total length is 11 cm of which 7 cm belongs to the sterile stalk and the clavate polyparium at its distal part bears 5 pairs of large polyps, 17 mm long and 3 mm wide. The general color is grey.

Distribution. In Japanese waters, recorded only from Sagami Bay, 300–400 fathoms.

NUTTING (1912) reported another species *K. hispidum* from the waters adjacent to Tosa Bay.

Fam. Virgulariidae VERRILL

Scytalium sprendens (THOMSON et HENDERSON)

Pennatula sprendens THOMSON et HENDERSON, 1906, p. 116, pl. 8, fig. 5.
Scytalium sprendens BALSS, 1910, p. 49, Taf. 2, fig. 5; THOMSON et RENNET, 1927, p. 137.

Material. Fragments. Tosa Bay. T. KAMOHARA coll. 1953.

Distribution. Common in Japanese waters, though the type locality is the Indian Ocean (11°49′30″ N., 92°55′ E., 55 fathoms).

Fam. Pennatulidae EHRENBERG

Pennatula murrayi KÖLLIKER

Pennatula murrayi KÖLLIKER, 1880, p. 5; BALSS, 1910, p. 56; NUTTING, 1912, p. 29; THOMSON et RENNET, 1927, p. 133.

Material. One young colony, about 9 cm long, base missing. Tosa Bay. T. KAMOHARA coll. 1953.

The specimen is orange colored, with slender axis, 1 mm in diameter. The leaves, though much broken, are slender and 6 mm in length.

Distribution. Common in deep waters around Japan, distributing further southwards.

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EXPLANATION OF PLATES V–VI

PLATE V

Fig. 1. *Telesto tubulosa* KINOSHITA. Colonies from Tosa Bay, Dr. T. KAMOHARA coll. 1953.

Fig. 2. *Paratelesto rosea* (KINOSHITA). Two fragments from off Kasiwazima, Prov. Tosa, Dr. K. KINOSHITA coll. 1909.

Fig. 3. *Paratelesto rosea* (KINOSHITA). A complete colony from Tanabe Bay, Prov. Kii, Mr. T. YAMAMOTO coll. 1955.

Fig. 4. *Paratelesto rosea* (KINOSHITA). A complete colony from Sisôzima, Tanabe Bay, Prov. Kii, Mr. T. YAMAMOTO coll. 1958.

Fig. 5. *Paratelesto kinoshitai*, gen. et spec. nov. Holotype from off Kasiwazima, Prov. Tosa, Dr. K. KINOSHITA coll. 1909.

(Scale applies to all photographs.)

PLATE VI

Fig. 6. *Anthelia tosana*, spec. nov. Holotype from Tosa Bay, Dr. T. KAMOHARA coll.

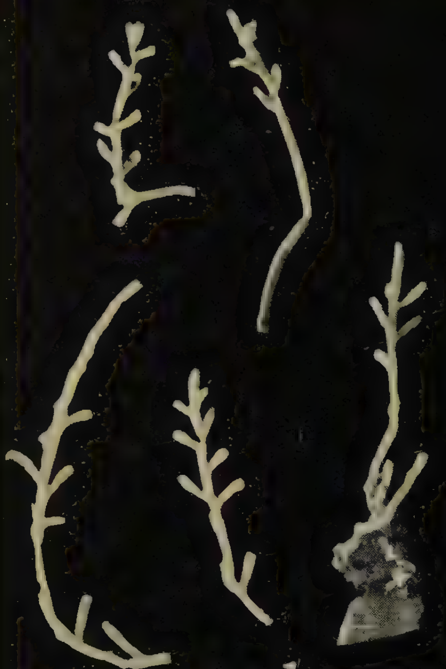
Fig. 7. *Dendronephthya querciformis*, KÜKENTHAL. A colony from Tosa Bay, Dr. T. KAMOHARA coll. 1953.

Fig. 8. *Melithaea ocracea* (LINNAEUS). Largest colony from Okinosima, Prov. Tosa, Mr. M. HORI coll. 1952. (Osaka Municipal Museum of Nat. Hist. Photograph. Annexed scale shows 30 cm in total length.)

Fig. 9. *Parisis minor* WRIGHT et STUDER. Fragments from off Kasiwazima, Prov. Tosa, Dr. K. KINOSHITA coll. 1909.

(Scale at 9 applies to all photographs except only 8.)

PLATE V



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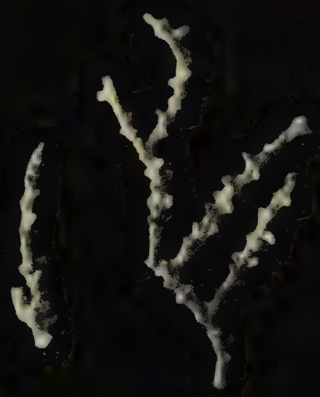

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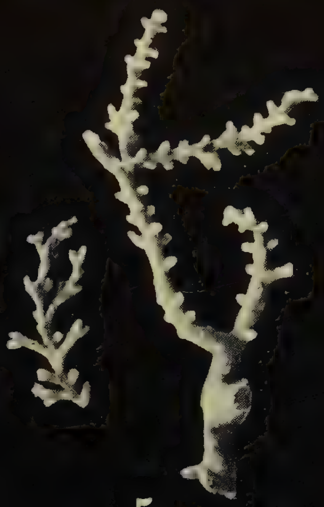

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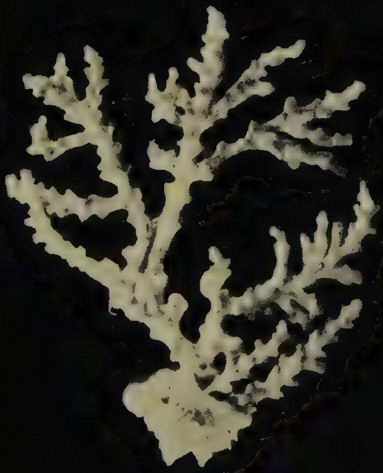

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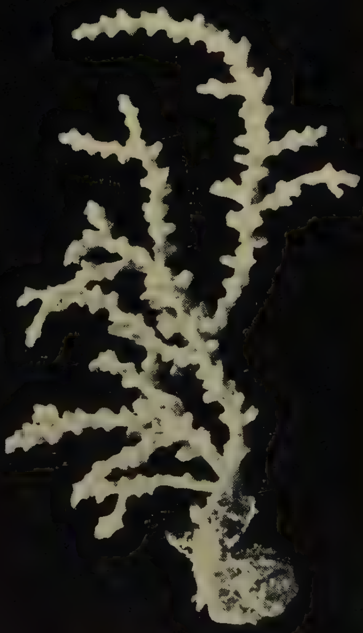

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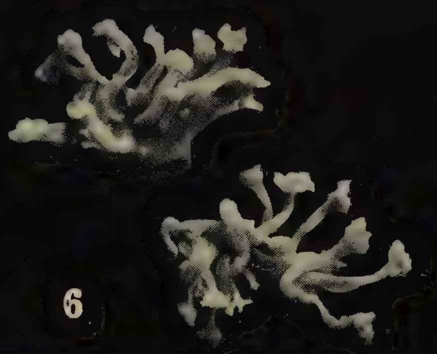
H. UTINOMI: OCTOCORALS FROM DEEP WATERS OF PROV. TOSA, SIKOKU.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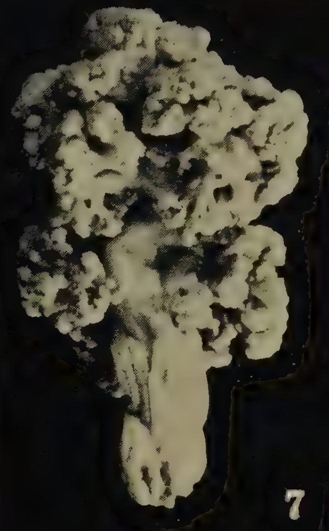
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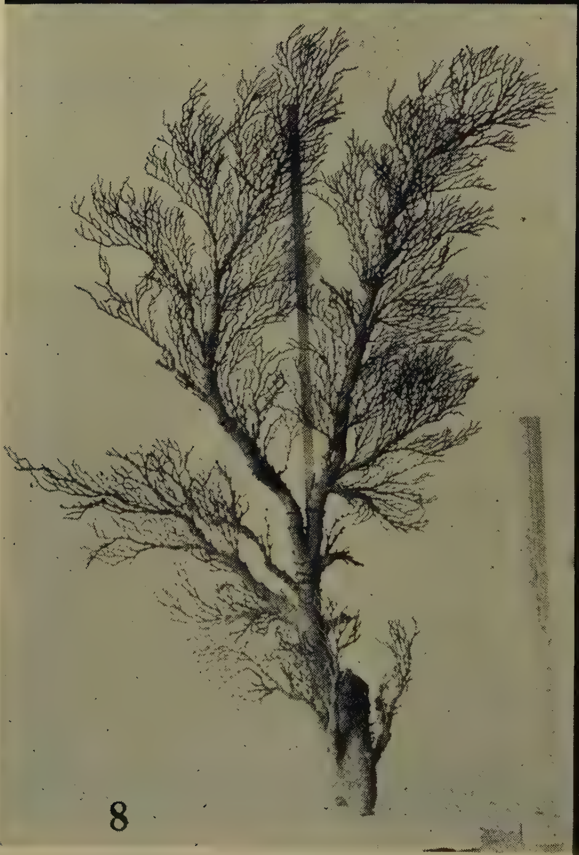
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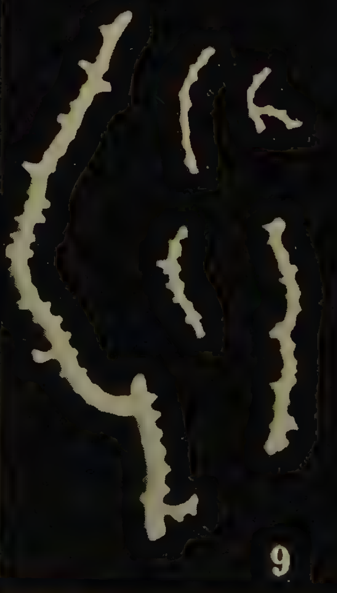
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H. UTINOMI: OCTOCORALS FROM DEEP WATERS OF PROV. TOSA, SIKOKU.

PRELIMINARY CHECK-LIST OF PLANKTON ORGANISMS FOUND IN TANABE BAY AND ITS ENVIRONS[1]

ISAMU YAMAZI

Seto Marine Biological Laboratory, Sirahama

This list of common plankton organisms found in Tanabe Bay and its environs is prepared mainly for the use of planktologists and for researchers or students learning the practical exercises in marine biology at our Laboratory, in order to indicate the general distribution of plankton organisms around the coast and to form a basis for a more complete list of the species occurring in our waters. The environmental conditions are briefly described for each common or characteristic species, with some short notes on their ecology.

In this list is excluded either of the transitory plankton such as those benthic forms that have a planktonic larval stage or the epibionts on planktonic or floating objects or organisms. The holoplankton organisms comprising both phyto- and zooplankton listed herein are summerized below.

	Class	Subclass or Order	Family	Genus	Species
Cyanophyceae (Blue-green Algae)	1	1	—	1	1
Bacillariaceae (Diatoms)	1	2	17	47	175
Mastigophora	1	2	4	21	82
Sarcodina	1	2	—	37	41
Ciliophora	1	1	12	26	54
Hydrozoa	1	3	—	47	54
Scyphozoa	1	3	—	10	10
Anthozoa	1	1	—	1	1
Ctenophora	1	4	—	9	9
Rotifera	1	1	—	2	2
Chaetopoda	1	—	—	6	18
Chaetognatha	1	—	—	5	16
Gastropoda	1	3	—	16	34
Crustacea	1	8	36	81	244
Tunicata	1	3	—	15	37
Total	15	34	69	324	778

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1) Contributions from the Seto Marine Biological Laboratory, No. 319.

The genera are listed alphabetically under the order or family and species alphabetically under the genus. Main synonyms are shown in brackets, when necessary.

The present list includes also the species that have been recorded by many authors and some unpublished species sketched or recorded by the late Mr. Jiro IKARI, formerly a member of our Laboratory staff.

The macroplankton samples have been collected with larval net which is one meter in diameter at the mouth and 2.6 meters long with silk bolting gauze at the upper and middle part (29 meshes/inch) and at the bottom (39 meshes/inch). The net was hauled horizontally for three minutes at each station from July, 1955 to January, 1957 in Tanabe Bay (HARADA, 1957).

The microplankton samples have been at times collected with KITAHARA's standard net, modified from HENSEN's net, with ca. 20 cm mouth diameter and 100 cm long, stretched with silk bolting gauze (XX–14), hauling vertically from the bottom to the surface during the years from 1954 to 1958 (YAMAZI, 1955; YAMAZI, 1958).

The author wishes to express his sincere thanks to Mr. E. HARADA for affording the materials of macroplankton and to Dr. Huzio UTINOMI and Dr. Takasi TOKIOKA for their kindness in giving valuable suggestions and in revising the scientific names in the preparation of the manuscript. The author is also indebted to the Japanese National Commission for UNESCO and the Ministry of Education for Grants-in-Aid to this study.

LIST OF THE SPECIES

Class **CYANOPHYCEAE** (Blue-green Algae)

Order HORMOGONEAE

Trichodesmium erythraeum EHRENBERG

Trichodesmium Tiebauti GOM.

Occurs in swarms, in open sea water outside the bay, chiefly in summer and autumn. Oceanic, tropical form. (YAMAZI, 1959, p. 38, 53, 160)

Class **BACILLARIACEAE** (Diatoms)

Order CENTRALES

Suborder *DISCINEAE*

Family 1. Melosiraceae

Melosira numuloides (DILLW.) AGARDH

Rare, in littoral and brackish water area. Tichopelagic, eurythermal form.

Melosira sulcata (EHRENBERG) KÜTZING

Not very common, inside the bay, in winter and spring. Tichopelagic, north-temperate form.

Family 2. Coscinodiscaceae

Actinoptychus undulatus (BAIL.) RALFS

Very rare in all seasons, occurs accidentally in plankton. Neritic and littoral, north and south temperate species. (YAMAZI, 1959, p. 22, 136)

Arachnoidiscus ornatus (BRÉB.) GREV.

Asteromphalus heptactis (BRÉB.) RALFS

Very rare, occasionally in winter and spring. Oceanic, temperate or subtropical species. (YAMAZI, 1959, p. 214)

Coscinodiscus asteriomphalus EHRENBERG

Common in spring and summer, outside and inside the bay. South-temperate species.

Coscinodiscus centralis EHRENBERG

Rare, inside and outside the bay, in the cold season. Oceanic and neritic, temperate or north temperate species. (YAMAŻI, 1959, p. 134)

Coscinodiscus concinnus W. SMITH

Rare, widely distributed, chiefly in winter and spring. Neritic, north temperate, euryhaline species.

Coscinodiscus excentricus EHRENBERG

Rare in the bay, in autumn and winter. Chiefly oceanic but frequently neritic.

Coscinodiscus gigas EHRENBERG

Commonest, especially in the cold season, inside and outside the bay, widely distributed, in almost all seasons. (YAMAZI, 1959, p. 21, 33, 135)

Coscinodiscus Granii GOUGH.

Very common, in winter and spring, inside and outside the inlet. Neritic, north-temperate and boreal species. (YAMAZI, 1959, p. 24, 136)

Coscinodiscus Janischii A. SCHMIDT

Rare, in warm seasons, widespread form.

Coscinodiscus lineatus EHRENBERG

Rare, off Sirahama, inside the bay, from winter to early summer, widespread form.

Coscinodiscus marginatus EHRENBERG

Not very common, from autumn to early summer, widely distributed. (YAMAZI, 1959, p. 136)

Coscinodiscus nitidus GREGORY

Rare, inside the bay, in spring and early summer, neritic species.

Coscinodiscus oculus-iridis EHRENBERG

Not common in the bay, chiefly in winter and spring, oceanic but frequently neritic. (YAMAZI, 1959, p. 134)

Coscinodiscus perforatus EHRENBERG

Very rare, outside the bay, in winter season, widespread temperate form. (YAMAZI, 1959, p. 134)

Coscinodiscus radiatus EHRENBERG

Rare, inside and outside the bay, in cold season. Oceanic and neritic, temperate species. (YAMAZI, 1959, p. 136, 207, 214)

Coscinodiscus stellaris ROPER

Rare, in the bay in autumn. Oceanic, widespread species. (YAMAZI, 1959, p. 22, 214)

Coscinodiscus wailesii GRAN & ANGST

One of the most abundant diatoms in winter, outside and inside the bay, northerly distributed species. (YAMAZI, 1959, p. 135)

Coscinodiscus sp.

Ethmodiscus Gazellae (JANISCH) HUSTEDT

Rare, in tow-netting, in open sea water outside the inlet, in spring and early summer. Oceanic, tropical species. (YAMAZI, 1959, p. 156)

Hemidiscus cuneiformis WALLICH

Very rare, outside the bay, in summer and autumn. Oceanic, tropical or subtropical form. (YAMAZI, 1959, p. 23, 156)

Planktoniella sol (WALLICH) SCHÜTT

Rare, found occasionally in spring and summer, chiefly outside the bay. Oceanic tropical species. (YAMAZI, 1959, p. 34, 201)

Family 3. Thalassiosiraceae

Lauderia borealis GRAN

Not very common, in spring and summer. Neritic, widely distributed, temperate species.

Lauderia flaccida (CAST.) PÉRAGALLO

Inside the bay. (IKARI, MS.)

Lauderia gracialis GRUN.

Very rare, found in winter in the bay. Neritic, north-temperate species.

Schröderella delicatula (PÉRAGALLO)

Rare in the bay, in spring and summer. Neritic, temperate species.

Thalassiosira condensata (CLEVE)

Thalassiosira decipiens (GRUN.)

Very rare, found occasionally in winter and early spring. Neritic, north-temperate species. (YAMAZI, 1959, p. 208)

Thalassiosira gravida CLEVE

Rare, found in winter and early spring. Neritic but frequently oceanic, north-temperate species. (YAMAZI, 1959, p. 208)

Thalassiosira rotula MEUNIER

Not common, outside and inside the inlet. Neritic, temperate and south-temperate species. (YAMAZI, 1959, p. 48)

Thalassiosira subtilis (OSTENFELD)

Very common in the bay, chiefly in coldest season. North-temperate, oceanic but frequently neritic species. (YAMAZI, 1959, p. 46)

Family 4. Skeletonemaceae

Skeletonema costatum (GREVILLE) CLEVE

Most abundant inside the bay, in almost all season. Eurythermal and euryhaline, neritic, widely distributed in all seas. (YAMAZI, 1959, p. 40, 132)

Stephanopyxis palmeriana (GREV.) GRUNOW

Fairly common, inside and outside the bay. Neritic, warm-water species. (YAMAZI, 1959, p. 40, 132)

Stephanopyxis turris (GREVILLE)

Very rare, in winter and spring, temperate and subtropical species. (YAMAZI, 1959, color pl. 4)

Family 5. Leptocylindraceae

Dactyliosolen antarcticus CASTRACANE

Rare, in winter and spring, outside the bay. Oceanic, temperate species. (YAMAZI, 1959, p. 40)

Dactyliosolen mediterraneus PÉRAGALLO [=*D. tenuis* (CL.) GRAN]

Common in the bay, chiefly in summer and autumn. Neritic, sporadically oceanic, widely distributed species. (YAMAZI, 1959, p. 216)

Guinardia flaccida (CASTRACANE) PÉRAGALLO

Common in the bay, in summer and autumn. Neritic south-temperate species. (YAMAZI, 1959, p. 40)

Leptocylindrus danicus CLEVE

Common in inner part of the bay, in autumn and winter. Neritic, temperate or north-temperate, widespread species. (YAMAZI, 1959, p. 40)

Family 6. Corethronaceae

Corethron hystrix HENSEN [=*C. criophilum* CASTR.]

Fairly common but never abundant, in winter. Oceanic, north-temperate species. (YAMAZI, 1959, p. 206)

Corethron pelagicum BRUN

Rare, in open water, outside the bay, from early summer to autumn. Oceanic, warm-water form. (YAMAZI, 1959, p. 156)

Suborder *SOLENIINEAE*

Family 7. Rhizosoleniaceae

Rhizosolenia acuminata (PÉRAG.) GRAN

Fairly common but not abundant in open water outside, from summer to autumn. Oceanic, subtropical or temperate species.

Rhizosolenia alata BRIGHTWELL

Common, in spring and autumn. Oceanic, sporadically neritic, temperate species. (YAMAZI 1959, p. 32, 206)

Rhizosolenia alata f. **gracillima** (CLEVE) GRUNOW

Common in the bay, in spring and summer, neritic, temperate species.

Rhizosolenia alata f. **indica** (PÉRAG.) OSTENFELD

Common, sometimes abundant, in warm season of summer and autumn. Oceanic, warm-water form. (YAMAZI, 1959 p. 204)

Rhizosolenia Bergonii PÉRAGALLO

Rare, outside the bay, in summer and autumn. Oceanic, south-temperate or subtropical warm-water species. (YAMAZI, 1959, p. 157, 204)

Rhizosolenia calcar avis M. SCHULTZE

Common or very abundant, in summer and autumn. Oceanic, tropical or subtropical warm-water species. (YAMAZI, 1959, p. 63, 157, 204)

Rhizosolenia Clevei OSTENFELD

Very rare in summer and autumn. Oceanic, warm-water species.

Rhizosolenia cylindrus CLEVE

Rarer in warm season. Neritic, tropical or subtropical form. (YAMAZI, 1959, p. 157)

Rhizosolenia delicatula CLEVE

Rarer in the bay, in warm season. Neritic, temperate species.

Rhizosolenia hebetata (BAILEY) GRAN f. **semispina** (HENSEN) GRAN

Common in warm season, chiefly in summer and autumn. Oceanic, warm-water species. (YAMAZI, 1959, p. 217)

Rhizosolenia imbricata BRIGHTWELL

Rarer in the bay, in summer and autumn. Oceanic, warm-water species.

Rhizosolenia imbricata var. **Schrubsolei** CLEVE

Rare in the bay, in spring and summer. Neritic, north-temperate species.

Rhizosolenia robusta NORMAN

Common in warm season, inside and outside the bay. Oceanic, widely distributed, especially in warm water. (YAMAZI, 1959, p. 157, 203)

Rhizosolenia setigera BRIGHTWELL

Commonest from early spring to early summer. Neritic, north-temperate or temperate species. (YAMAZI, 1959, p. 157)

Rhizosolenia stolterfothii PÉRAGALLO

Very common, from spring to summer, neritic sometimes oceanic, very widespread, south-temperate or tropical species. (YAMAZI, 1959, p. 42)

Rhizosolenia styliformis BRIGTWELL

Common from spring to autumn. Oceanic, temperate and north-temperate species.

Rhizosolenia styliformis var. **latissima** BRIGHTWELL

Commonest in early summer but frequently in warm season. Oceanic, temperate and north-temperate species. (YAMAZI, 1959, p. 204)

Suborder *BIDDULPHIINEAE*

Family 8. Bacteriastraceae

Bacteriastrum comosum PAVILLARD

IKARI (1927); YAMAZI, (1959, p. 160)

Bacteriastrum comosum var. **hispida** (CASTR.) SCHRÖDER

IKARI (1927); YAMAZI, (1959, p. 160)

Bacteriastrum delicatulum CLEVE

Common in the bay, in summer and autumn. Oceanic, temperate species.

Bacteriastrum elongatum CLEVE

Rare, in summer and autumn. Oceanic, temperate species. (IKARI, 1927)

Bacteriastrum elongatum CLEVE var. **diversum** IKARI

IKARI (1927).

Bacteriastrum hyalinum LAUDER

Common in the bay, in almost all seasons. Neritic, littoral form. (YAMAZI, 1959, p. 64)

Bacteriastrum hyalinum LAUDER var. **princeps** (CASTRACANE) IKARI

Nertic, warm-water species, common.

Bacteriastrum mediterraneum PAVILLARD

IKARI (1927).

Bacteriastrum minum KARSTEN

In summer, rarer in the bay (IKARI, 1927).

Bacteriastrum biconicum PAVILLARD

Rare in the bay (IKARI, 1927).

Bacteriastrum varians LAUDER

Commonest *Bacteriastrum* in our region, in almost all seasons, sometimes in swarms inside. Neritic and littoral, widespread form.

Family 9. Chaetoceraceae

Chaetoceros (Phaeoceros) atlanticus CLEVE

Rarer in the bay, in coldest season. Oceanic, typically northern, arctic and boreal form. (YAMAZI, 1959, p. 205, 213)

Chaetoceros (Phaeoceros) atlanticus var. **neapolitanus** (SCHRÖDER) HUSTEDT

Oceanic southern, temperate or subtropica form. Rarer, found occasionally in summer and autum. (YAMAZI, 1959, p. 157, 203)

Chaetoceros (Phaeoceros) coarctatus LAUDER

Rather common but never abundant. Oceanic, subtropical or tropical form. (YAMAZI, 1959, p. 103, 158)

Chaetoceros (Phaeoceros) castracanei KARSTEN

Oceanic form. (IKARI, 1926)

Chaetoceros (Phaeoceros) dadayi PAVILLARD

Very rarely found in warm season, in open sea water off Sirahama. Oceanic, tropical form.

Chaetoceros (Phaeoceros) danicus CLEVE

Rarer in littoral zone. North-temperate species.

Chaetoceros (Phaeoceros) densus CLEVE

Commonly found in cold season. Widespread, northern species.

Chaetoceros (Phaeoceros) denticulatum LAUDER

Rare in the bay, in open sea water off Sirahama. Oceanic, subtropical species. (YAMAZI, 1959, p. 158)

Chaetoceros (Phaeoceros) Eibenii GRUNOW

Fairly common, in open sea water. Neritic, temperate species. (YAMAZI, 1959, p. 158)

Chaetoceros (Phaeoceros) indicum KARSTEN [=*C. nanodenticulatum* OKAMURA]

Chaetoceros (Phaeoceros) okamurai IKARI

Rarely found in the bay. (IKARI, 1928)

Chaetoceros (Phaeoceros) pendulus KARSTEN

Rarely found in open sea water, in summer and autumn. Oceanic, temperate or subtropical form.

Chaetoceros (Phaeoceros) peruvianus BRIGHTWELL

Commonly found in open water almost in warm season. Oceanic, temperate or tropical form. (YAMAZI, 1959, p. 159)

Chaetoceros (Phaeoceros) pseudodichaeta IKARI

(IKARI (1926).

Chaetoceros (Phaeoceros) rostratus LAUDER

Very rare in the bay, in warm season. Oceanic, subtropical species.

Chaetoceros (Phaeoceros) tetrastichon CLEVE

Very rarely found, occasionally in warm season, in open sea water. Oceanic, subtropical and south-temperate species.

Chaetoceros (Hyalochaete) affinis LAUDER [=*C. Schüttii* CLEVE ; *C. javanicum* CLEVE]

Commonest *Chaetoceros* in our region, throughout the year, from spring to autumn. Neritic, south-temperate but frequently widespread. (YAMAZI, 1959, p. 139)

Chaetoceros (Hyalochaete) anastomosans GRUNOW

Rare, occasionally met with in warm season. Neritic, south-temperate species.

Chaetoceros (Hyalochaete) brevis SCHÜTT

Rare, in warm season. Neritic, south-temperate warm-water species. (YAMAZI, 1959, p. 140)

Chaetoceros (**Hyalochaete**) **compactum** IKARI

Rare, in the innermost part of the bay, in summer. Neritic and littoral form. (YAMAZI, 1959, p. 142)

Chaetoceros (**Hyalochaete**) **compressus** LAUDER

One of the most abundant species, everywhere, throughout the year, especially in spring and autumn. Neritic, from boreal to south temperate. (YAMAZI, 1959, p. 138)

Chaetoceros (**Hyalochaete**) **constrictus** GRAN

Common in winter and spring. Neritic, north-temperate, cold water species. (YAMAZI, 1959, p. 139)

Chaetoceros (**Hyalochaete**) **costatus** PAVILLARD

Rare, in late summer and autumn, inside the bay. Neritic, warm-water subtropical species. (YAMAZI, 1959, p. 140)

Chaetoceros (**Hyalochaete**) **curvisetus** CLEVE

Very common, in the innermost part of the bay. Neritic, south-temperate species. (YAMAZI, 1959, p. 203)

Chaetoceros (**Hyalochaete**) **debilis** CLEVE

Common but not abundant, in cold seasons. Neritic, north-temperate species. (YAMAZI, 1959, p. 142)

Chaetoceros (**Hyalochaete**) **decipiens** CLEVE

Very abundant, chiefly in winter and spring, inside and outside the bay, one of the most abundant *Chaetoceros*. Oceanic and neritic widely distributed, northern form. (YAMAZI, 1959, p. 137)

Chaetoceros (**Hyalochaete**) **decipiens** f. **singularis** GRAN

North-temperate species.

Chaetoceros (**Hyalochaete**) **didymus** EHRENBERG

Common in spring and summer. Neritic, south-temperate species. (YAMAZI, 1959, p. 137)

Chaetoceros (**Hyalochaete**) **didymus** var. **protuberans** (LAUDER) GRAN & YENDO

Very common in cold seasons. Euryhaline and eurythermal species.

Chaetoceros (**Hyalochaete**) **didymus** var. **anglica** (GRUNOW) GRAN

Very common, in warm seasons than var. *protuberans*, from early summer to autumn. Eurythermal form. (YAMAZI, 1959, p. 138)

Chaetoceros (**Hyalochaete**) **distans** CLEVE

Common in the inlet waters, in summer. Neritic, warm-water species. (YAMAZI, 1959, p. 18, 140)

Chaetoceros (**Hyalochaete**) **diversus** CLEVE

Very rare, in outside waters, in summer and autumn. Neritic, tropical and subtropical species. (YAMAZI, 1959, p. 24, 159)

Chaetoceros (**Hyalochaete**) **Frichei** HUSTEDT

In the inlet waters. (IKARI, 1926)

Chaetoceros (**Hyalochaete**) **hispidum** BRIGHTWELL

Warm-water species (IKARI, 1926)

Chaetoceros (**Hyalochaete**) **laciniosus** SCHÜTT

Fairly common, in summer, inside the bay. Neritic, south-temperate and subtropical species.

Chaetoceros (Hyalochaete) lauderi RALFS.

Not common, chiefly in summer. Neritic, warm-water species. (YAMAZI, 1959, p. 137)

Chaetoceros (Hyalochaete) Lorenzianus GRUNOW

Very common almost everywhere, from early summer to autumn. Neritic, subtropical and temperate, widespread form. (YAMAZI, 1959, p. 25, 137)

Chaetoceros (Hyalochaete) messanensis CASTRACANE [=*C. furca* CLEVE]

Found occasionally in open sea water outside the bay, in summer and autumn. Oceanic tropical and subtropical species. (YAMAZI, 1959, p. 159)

Chaetoceros (Hyalochaete) paradoxus CLEVE

Common inside, in warm season. Neritic, subtropical, warm-water species. (YAMAZI, 1959, p. 140)

Chaetoceros (Hyalochaete) pelagicus CLEVE

Common inside the bay, in warm season. Neritic, temperate form.

Chaetoceros (Hyalochaete) pseudocurvisetus MANGIN

Not common, in the inlet, in warm season. Neritic. Tropical and subtropical species. (YAMAZI, 1959, p. 141)

Chaetoceros (Hyalochaete) radicans SCHÜTT [=*C. scolopendra* CLEVE]

Very abundant in the inlet waters, throughout the year, especially in spring and summer. Neritic, north temperate species. (YAMAZI, 1959, p. 142)

Chaetoceros (Hyalochaete) seiracanthus GRAN

Rare, in winter and spring, inside the inlet. Neritic and bittoral zone, north-temperate form but widely distributed. (YAMAZI, 1959, p. 64, 141)

Chaetoceros (Hyalochaete) setoensis IKARI

Common, inside the inlet. Neritic, warm-water form.

Chaetoceros (Hyalochaete) siamensis OSTENFELD

Rare, in the inlet, from summer to autumn. Neritic, warm-water species. (YAMAZI, 1959, p. 139)

Chaetoceros (Hyalochaete) socialis LAUDER

Common and often very abundant inside the bay, in winter and early spring. Neritic, north-temperate, cold-water species. (YAMAZI, 1959, p. 48)

Chaetoceros (Hyalochaete) subsecundus (GRAN) HUSTEDT [=*C. diadema* (EHRENBERG) CLEVE

Common from winter to spring, inside the inlet. Neritic. Cold water species but widespread. (YAMAZI, 1959, p. 39, 141)

Chaetoceros (Hyalochaete) tortissimus GRAN

Very rare, in the inlet, in the cold season during winter and spring. Neritic, north-temperate species. (YAMAZI, 1959, p. 142)

Chaetoceros (Hyalochaete) Van Heurckii GRAN

Common, inside the bay, from winter to early spring. Neritic, widespread, probably confused with *Ch. constrictus*. (YAMAZI, 1959, p. 64, 139)

Chaetoceros (Hyalochaete) Weissflogii SCHÜTT

Not common inside the bay, especially in summer and autumn. Neritic, warm-water form. (YAMAZI, 1959, p. 137)

Family 10. Biddulphiaceae

Bellerochea malleus (BRIGHTWELL) VAN HEURCK

Very rare, in the bay, and in the open water, in summer. Neritic, warm-water species. (YAMAZI, 1959, p. 151)

Biddulphia aurita (LYNGB.)

Rare in the bay, in cold season. Neritic and littoral, widely distributed, but northern species. (YAMAZI, 1959, p. 207)

Biddulphia longicruris GREVILLE var. **japonica** GRUNOW

Rare in the bay, in summer and autumn. Neritic. Warm-water species. (YAMAZI, 1959, p. 150)

Biddulphia mobiliensis BAILEY

Not very common, in summer season. Neritic, widely distributed, truly planktonic, temperate and south-temperate species. (YAMAZI, 1959, p. 149)

Biddulphia pulchella GRAY [=*B. biddulphiana* BAYER]

Occurs in plankton accidentally (tichopelagic) in spring and summer but a bottom form. (YAMAZI, 1959, p. 149)

Biddulphia sinensis GREVILLE

Found occasionally in warm seasons, outside the bay. Oceanic. Warm-water species, but sometimes common in littoral. (YAMAZI, 1959, p. 65, 150)

Biddulphia Tuomeyi (BAIL)

Very rare, widely distributed, neritic form.

Cerataulina Bergonii H. PÉRAGALLO

Rare in the inlet, in summer and autumn. Neritic, south-temperate species. (YAMAZI, 1959, p. 150)

Cerataulina compacta OSTENFELD

Rare, in the open sea water at the mouth, in summer and autumn. Neritic. south-temperate and subtropical species.

Ditylum Brightwelli (WEST) GRUNOW

Common in the inlet, in autumn and winter. Neritic, south-temperate species. (YAMAZI, 1956, p. 63)

Ditylum sol GRUNOW

Common but not abundant, in the open sea water, in summer and autumn. Neritic, south-temperate and subtropical species. (YAMAZI, 1959, p. 23, 63)

Hemiaulus Haucki GRUNOW

Very rare, found occasionally in open sea water, in summer and autumn. Oceanic or neritic, temperate and subtropical form.

Hemiaulus membranaceus CLEVE

Very rare, in the offshore water near the mouth of the bay, in warm season. Probably oceanic, tropical species.

Hemiaulus sinensis GREVILLE

Not very common, in open sea water outside the bay, from summer to autumn. Neritic. South-temperate or subtropical form. (YAMAZI, 1959, p. 204)

Lithodesmium undulatum EHRENBERG

Very rare, in summer season. Neritic, south-temperate species.

Triceratium favus EHRENBERG

Very rare, occasionally in warm seasons. Tichopelagic, widely distributed in the bay. (YAMAZI, 1959, p. 151)

Triceratium gibbosum BAIL

Common inside in the bay, in spring. Neritic, tichopelagic species, widely distributed. (YAMAZI, 1959, p. 149)

Triceratium reticulum EHRENBERG

Very rare, in the bay, in warm seasons. (YAMAZI, 1959, p. 151)

Triceratium revale A. SCHMIDT

Very rare, in spring and autumn, neritic, tichopelagic, widely distributed. (YAMAZI, 1959, p. 151)

Family 11. Eucampiaceae

Climacodium biconcavum CLEVE

Very rare, in the open sea water, in summer and autumn. Oceanic, south-temperate and tropical species. (YAMAZI, 1959, p. 39, 160)

Climacodium Frauenfeldianum GRUNOW

Very rare, in the open sea water, outer part of the bay, in warm season. Oceanic, tropical or subtropical species. (YAMAZI, 1959, p. 41, 203)

Eucampia cornuta (CLEVE) GRUNOW

Rarely found in the open sea water, in warm season. Neritic, tropical species. Warmer water species than *E. zoodiacus.*

Eucampia zoodiacus EHRENBERG

Abundant, sometimes in swarms, from autumn to spring. Neritic, south-temperate form. (YAMAZI, 1959, p. 42, 133)

Streptotheca indica KARSTEN

Very rare, in open sea water, in summer and autumn. (YAMAZI, 1959, p. 39, color pl. 4)

Streptotheca thamensis SCHRUBSOLE

Very rare, in the inlet, from autumn to spring. Neritic, north-temperate species.

Order PENNALES

Suborder *ARAPHIDINEAE*

Family 12. Fragilariaceae

Asterionella japonica CLEVE

Common in the bay, in winter and spring, rare in summer. Neritic, south-temperate, widely distributed species. (YAMAZI, 1959, p. 44)

Asterionella kariana GRUNOW

Rarer in the bay, in cold season. Neritic, cold-water species.

Asterionella notata GRUNOW

Rarer in the bay, in cold season. (YAMAZI, 1959, p. 147)

Thalassionema (=Thalassiothrix) **nitzschioides** GRUNOW

Present throughout the year common inside the bay, especially in summer and autumn. Neritic and littoral, widepread, temperate species. (YAMAZI, 1959, p. 49)

Thalassiothrix Frauenfeldii GRUNOW

Very abundant in neritic, littoral and oceanic zone. Occurs in almost all seasons, especially in summer and autumn. South-temperate form. (YAMAZI, 1959, p. 44, 133)

Thalassiothrix longissima CLEVE & GRUN.

Common, in the bay, especially from autumn to spring. Oceanic, north-temperate and boreal species, widespread. (YAMAZI, 1959, p. 32)

Family 13. Tabellariaceae

Climacosphenia moniligera EHRENBERG

Littoral, in innermost region, abundant in warm seasons. Tichopelagic form. (YAMAZI, 1959, p. 152)

Climacosphenia sp.

Licmophora abbreviata AGARDH [=*L. Lyngbyei* (KÜTZ.) GRAN]

Littoral, occurs in plankton accidentally but a bottom species. Widely distributed. (YAMAZI, 1959, p. 146)

Licmophora flabellata (GARM.) AGARDH.

Common in the inlet waters, in spring and summer, neritic, tichopelagic. (YAMAZI, 1959, p. 145)

Rhabdonema adriaticum KÜTZING

Ubiquitous, temperate-water species. (YAMAZI, 1959, p. 41, 151)

Striatella unipunctata (LYN.) AGARDH

Common in the innermost area. Tichopelagic, temperate species. (YAMAZI, 1959, p. 41, 148)

Family 14. Achnanthaceae

Achnanthes longipes AGARDH

Tichopelagic, littoral, north-temperate species. (YAMAZI, 1959, p. 18)

Cocconeis scutellum EHRENBERG

Very rare, often found in plankton but a bottom form.

Suborder *BIRAPHIDINEAE*

Family 15. Naviclaceae

Amphora laevis GREG. [=*A. nobilis* FLÖGEL]

Very rare, in inlet waters, littoral, tichopelagic species. Rare in warm season. (YAMAZI, 1959, p. 148)

Pleurosigma angulatum (QUEK.) W. SMITH

Occurs in plankton accidentally (tichopelagic), widespread, neritic and littoral species, very rare. (YAMAZI, 1959, p. 155)

Pleurosigma intermedium W. SMITH

Very rare, in inlet waters, in summer season, tichopelagic, littoral species. (YAMAZI, 1959, p. 154)

Family 16. Epithemiaceae

Denticula sp. 1

Very rare, in the inner part of the inlet.

Denticula sp. 2

(YAMAZI, 1959, p. 207, 208)

Family 17. Nitzschiaceae

Nitzschia closterium W. SMITH

Common, in the inlet waters, throughout the year, frequently in the plankton, widely distributed, euryhaline species. (YAMAZI, 1959, p. 153)

Nitzschia delicatissima CLEVE

Common in the inlet waters, from autumn to spring, ubiquitous but northern species.

Nitzschia longissima (BRÉB.) GRAN

Rare, in the bay water, in spring and summer. Littoral, tichopelagic species. Never in large numbers. (YAMAZI, 1959, p. 153)

Nitzschia longissima var. **reversa** W. SMITH

Very rare, in bay water in summer to winter. Tichopelagic, littoral species.

Nitzschia pacifica CUPP

Rare in the bay, in spring and summer, neritic, sporadically oceanic, temperate-water species. Present with *N. seriata*. (YAMAZI, 1959, p. 45, 133, 153)

Nitzschia (=Bacillaria) **paradoxa** GMELIN

Rare in inlet waters, in spring and summer. Widespread, euryhaline, littoral, marine and brackish-water, tichopelagic species. (YAMAZI, p. 45, 133, 153)

Nitzschia seriata CLEVE

Very common, all the year round, inside and outside the bay, ubiquitous. Euryhaline and eurythermal, neritic and littoral species. (YAMAZI, 1959, p. 133)

Nitzschia sigma (KÜTZ.) W. SMITH

Very rare, in the inlet waters. Widespred, tichopelagic species. (YAMAZI, 1959, p. 153)

Suborder *SURIRELLINEAE*

Family 18. Surirellaceae

Campylodiscus undulatus GREV.

Very rare, in the inlet waters. Littoral, tichopelagic species.

Surirella cuneata A. S.

Very rare, in spring and autumn. Littoral, tichopelagic species.

Phylum **PROTOZOA**

Class **MASTIGOPHORA**

Order CHRYSOMONADINA

Dictiocha fibula (EHRENBERG)

Very common, centrifuged, in the inner part of the bay. (YAMAZI, 1959, p. 128)

Dictiocha fibula var. **stapedia** (HAECKEL) LEMMERMANN

Occasionally common, centrifuged, in the inner part of the bay. Found in Sept. (IKARI, MS)

Distephanus speculum (EHRENBERG)

Rare, centrifuged, inside the bay. (YAMAZI, 1959, p. 212; IKARI, MS)

Distephanus speculum var. **pentagonum** SCHULZ

Rare, centrifuged in the innermost part of the bay. Found in October. (IKARI, MS)

Distephanus speculum var. **polyactis** (EHRENBERG) LEMMERMANN

Rare, centrifuged, in the innermost part of the inlet, in July. (IKARI, MS)

Mesocera polymorpha var. **bioctonaria** (EHRBG.) LEMMERMANN

Rare, centrifuged, inside the bay. Found in October. (IKARI, MS)

Order DINOFLAGELLATA

Family 1. Noctilucidae

Noctiluca scintillans MACARTNEY

Very common, throughout the year, almost everywhere, especially in the innermost area of inlets, sometimes very abundant in swarms from early winter to spring. Ubiquitous species. (YAMAZI, 1959, p. 52, 62, 118)

Family 2. Phytodinidae

Pyrocystis fusiformis MURRAY

Very rare, found in warm seasons, in the open sea water outside the bay. Oceanic, warm-water form. (YAMAZI, 1959, p. 172)

Pyrocystis hamulus CLEVE var. **inaequalis** SCHRÖDER

Very rare, in summer, outside the bay. Oceanic, warm-water species. (YAMAZI, 1959, p. 61, 172)

Pyrocystis hamulus CLEVE var. **semicircularis** SCHRÖDER

Very rare, in open sea water outside the bay. Oceanic, warm-water species.

Pyrocystis lunula SCHÜTT

Rare, in open-sea water, in late spring and summer. Oceanic, widespread species.

Pyrocystis noctiluca MURRAY

Fairly common, in warm season, in open sea waters. Oceanic, ubiquitous, warm-water species. (YAMAZI, 1959, p. 52, 61, 123, 172)

Family 3. Prorocentridae

Prorocentrum micans EHRENBERG

Rare, in the innermost part of the inlet but sometimes common, centrifuged, neritic and littoral form. (YAMAZI, 1959, p. 161)

Family 4. Peridiniidae

Amphysolenia bidentata SCHRÖDER

Occasionaly caught outside the bay, in summer and autumn. Oceanic, warm-water species. (YAMAZI, 1959, p. 162)

Amphysolenia thrinax SCHÜTT

Rare, in open sea outside the bay, in summer and autumn. Oceanic, warm-water species. (YAMAZI, 1959, p. 162)

Blepharocysta splender maris EHRENBERG

Very rare but occasionally found in open sea water near the mouth, in summer and autumn. Oceanic, warm-water species.

Ceratium belone CLEVE

Rare, in the mouth of the bay, in warm season. (YAMAZI, 1959, p. 166)

Ceratium candelabrum (EHRENBERG) STEIN

Very rare, found outside the bay, in summer and autumn. Warm-water, oceanic species. (YAMAZI, 1959, p. 171).

Ceratium candelabrum var. **dilatatum** (GOURR.) JÖRGENSEN

Very rare, in open sea water outside, in warm seasons. (YAMAZI, 1959, p. 62)

Ceratium carriense GOURRET

Rare, at the mouth of the bay, in summer and autumn. Oceanic, warm-water species, in Kurosio Current. (YAMAZI, 1959, p. 167)

Ceratium carriense f. **ceylanicum** (B. SCHRÖD.) JÖRGENSEN

Outside, rare, in warm water season. Oceanic, in warm Kurosio Current. (YAMAZI, 1959, p. 28, 168)

Ceratium contortum (GOURR.) CLEVE

Very rare, in open sea water, warm seasons. Oceanic species.

Ceratium deflexum (KOFOID) JÖRGENSEN

Very rare, in open sea outside the bay, in summer and autumn. Oceanic, warm-water species. (YAMAZI, 1959, p. 167)

Ceratium extensum (GOURRET) CLEVE

Very rare, open-sea water, summer and autumn. Ubiquitous, warm-water species.

Ceratium furca (EHRENBERG) DUJARDIN

Very common, found almost everywhere, especially inside the bay, in spring and summer. Widespread species. (YAMAZI, 1959, p. 128, 165).

Ceratium furca eugrammum JÖRGENSEN

Common, inside the bay, spring and summer.

Ceratium fusus (EHRENBERG) DUJARDIN

Common, inside and outside the inlet, in summer. (YAMAZI, 1959, p. 32, 166)

Ceratium fusus seta (EHRENBERG) JÖRGENSEN

Common, inside and outside the bay, in summer (YAMAZI, 1959, p. 166)

Ceratium gibberum GOURRET

Outside the inlet, rare, in summer and autumn. Warm-water species. (YAMAZI, 1959, p. 170)

Ceratium gibberum f. **sinistrum** GOURRET

Outside the inlet, rare, in summer and autumn. (YAMAZI, 1959, p. 43)

Ceratium gravidum GOURRET

Very rare, found outside the inlet, in summer and autumn. Oceanic, warm-water species. (YAMAZI, 1959, p. 36)

Ceratium incisum (KARSTEN) JÖRGENSEN

Very rare, found in the open sea water off the inlet, in summer and autumn. Warm water species. (YAMAZI, 1959, p. 166)

Ceratium inflexum (GOURRET) KOFOID

In open sea water, very rare, in summer and autumn. Offshore-water form.

Ceratium intermedium (JÖRG.) JÖRGENSEN

Found almost everywhere, throughout the year, especially in summer and autumn. (YAMAZI, 1959, p. 168, 169)

Ceratium Kofoidi JÖRGENSEN

Rare, in open sea water near the mouth, in summer and autumn. Warm water form. (YAMAZI, 1959, p. 165)

Ceratium macroceros (EHRENBERG) CLEVE

Occasionally common. outside the bay, in summer and autumn. Warm water form. (YAMAZI, 1959, p. 168).

Ceratsum massiliense (GOURRET) JÖGENSEN

Common, open sea water near the mouth, in summer and autumn. (YAMAZI, 1959, p. 169)

Ceratium molle KOFOID

Rare, outside the inlet, in warm season. Oceanic, warm-water species. (YAMAZI, 1959, p. 169)

Ceratium palmatum var. **ranipes** (CLEVE) JÖRGENSEN

Very rare, found occasionally outside the bay, in warm seasons. (YAMAZI, 1959, p. 31)

Ceratium pentagonum GOURRET

Sometimes in numbers in open sea waters, in warm season.

Ceratium pennatum KOFOID

Rare, in open sea water, warm-water form. (YAMAZI, 1959, p. 166)

Ceratium platycorne V. DADAY

Very rare, in open water, summer and autumn, oceanic, warm-water species.

Ceratium pulchellum SCHRÖDER

Rare, outside the inlet, in summer and autumn. Oceanic, warm-water species.

Ceratium reticulum (POCHET) f. **contortum** (LEMM.)

Very rare, in summer, warm water species.

Ceratium strictum (OKAMURA et NISHIKAWA) KOFOID

Outside the bay, very rare, in summer and autumn. Warm-water form. (YAMAZI, 1959, p. 166)

Ceratium sumatranum (KARSTEN) JÖRGENSEN

Fairly common, outside the bay, in summer and autumn, warm-water species. (YAMAZI, 1959, p. 43, 62)

Ceratium sumatranum f. **angulatum** JÖRGENSEN

Rare, outside the bay, in summer and autumn. Oceanic, warm-water species. (YAMAZI, 1959, p. 170)

Ceratium tenue (OSTF. et SCHM.) JÖRGENSEN

Outside the inlet, warm water species.

Ceratum tenue var. **buceros** (ZACHARIAS) JÖRGENSEN

Warm water species. (YAMAZI, 1959, p. 168)

Ceratium trichoceros (EHRENBERG) KOFOID

Very common at times in swarm, in warm seasons. (YAMAZI, 1959, 168)

Ceratium tripos (O. F. MÜLLER) NITSCH.

Very common, inside and outside the inlet, in summer and autumn. Widely distributed (YAMAZI, 1959, p. 171)

Ceratium vultur CLEVE

Very rare, in open sea waters near the mouth, in summer. Oceanic, warm-water species. (YAMAZI, 1959, p. 169)

Ceratium sp. 1

(YAMAZI, 1959, p. 166)

Ceratium sp. 2

(YAMAZI, 1959, p. 170)

Ceratocoris horrida STEIN

Fairly common, in open sea water, in summer and autumn. Oceanic, warm-water species.

Dinophysis hastatus STEIN

Very rare, in open water outside the bay, in summer and autumn.

Dinophysis homunculus STEIN

Rare, in open sea outside the bay, in warm seasons. YAMAZI, 1959, p. 161)

Dinophysis homunculus f. **pedunculatus** SCHMIDT

Occasionally outside the bay, summer and autumn. Warm-water species.

Dinophysis ovum SCHÜTT

Early spring and summer, very rare in inner part of the bay.

Diplopsalis lenticula BERGH

Rare, found inside and outside the bay, in early spring and summer. (YAMAZI, 1959, p. 163)

Glenodinium danicum PAULSEN ?

Common at times, in summer, inside the inlet. (YAMAZI, 1959, p. 128)

Goniaulax polygramma STEIN

Rare, in the inlet. Warm-water, neritic species.

Goniodoma polyedricum (POUCHET)

Very rare, in open sea water, in summer. Oceanic, warm-water species.

Orinthocercus magnificus STEIN

Only once found outside the bay, in summer, oceanic, warm-water species. (YAMAZI, 1959, p. 161)

Orinthocercus splendicus STEIN

Very rare, found occasionally in summer. Oceanic, warm-water species.

Oxytoxum milneri MÜRR. et WHITT.

Very rare, in the open sea, in summer. Tropical, oceanic form.

Oxytoxum scolopax STEIN

Very rare, in open sea water, in summer. Oceanic, tropical species.

Peridinium conicum (GRAN) OSTENFELD et SCHMIDT

Common, inside and outside the bay, widespread. (YAMAZI, 1956, p. 163)

Peridinium crassipes KOFOID

Fairly common, in open-sea water outside and inside the bay, from winter to early summer.

Peridinium depressum BAILEY

Common, in open sea water outside the bay, in summer and autumn, widespread. (YAMAZI, 1959, p. 53, 163)

Peridinium globulum STEIN

Very rare, inside and outside the bay, in summer and autumn.

Peridinium grande KOFOID

Common, inside and outside the bay, widely distributed.

Peridinium Granii OSTENFELD

Rare, inside and outside, in summer and autumn.

Peridinium longipes KARSTEN

Very rare in open sea water, in summer and autumn. (YAMAZI, 1959, p. 161)

Peridinium oceanicum VANHÖFFEN var. **oblongum** AURIV.

Common, in the innermost part of the bay, in summer and autumn. Neritic and littoral species. (YAMAZI, 1959, p. 128, 164)

Peridinium pallidum OSTENFELD

Not very common in the bay, from early summer to autumn.

Peridinium pentagonum GRAN

Not common, in spring and summer, inside and outside the bay. (YAMAZI, 1959, p. 164)

Peridinium pyriforme PAULSEN

Rarer, inside and outside the bay, in summer and autumn.

Peridinium sphaericum OKAMURA

Very rare, in the inner part, in summer and autumn.

Peridinium steinii JÖRGENSEN

Rare, inside and outside the bay, in summer and autumn.

Pyrophacus horologicum STEIN

Common in the open sea, in warm season. Oceanic, tropical or subtropical species. (YAMAZI, 1959, p. 34)

Triposolenia bicornis (KOFOID)

Very rare, outside the bay, in summer. Oceanic, tropical species.

Class SARCODINA

Order FORAMINIFERA

Globigerina bulloides D'ORBIGNY

Sometimes frequent, in summer and autumn. Oceanic, warm-water species. (YAMAZI, 1959, p. 26)

Orbulina universa D'ORBIGNY

Very rare, outer part of the bay, in warm season. Oceanic, warm-water species.

Tretomphalus bulloides (D'ORBIGNY)

Very rare, only once found outside the inlet, in summer. Oceanic, warm-water species.

Order RADIOLARIA

Abyla sp.	(YAMAZI, 1959, p. 177)
Abylopsis sp.	(YAMAZI, 1959, p. 177)
Acanthochiasma sp.	(YAMAZI, 1959, p. 173)
Acanthometron pellucidum (J. MÜLLER)	(YAMAZI, 1959, p. 174)
Acanthonina crux CLEVE	(YAMAZI, 1959, p. 173)
Amphilonche belonoides HAECKEL	
Amphibelone sp.	(YAMAZI, 1959, p. 173)
Amphipule sp.	(IKARI, MS.)
Anchylometra sp.	(YAMAZI, 1959, p. 180)
Astroma sp.	(YAMAZI, 1959, p. 175)
Aulacantha scolimantha HAECKEL	(YAMAZI, 1959, p. 173)
Aulosphaera cruciata HAECKEL	
Cladococcus sp.	(IKARI, MS.)
Coelodendrum sp.	(IKARI, MS.)
Colozoum amoeboides HAECKEL	(IKARI, MS.)
Colozoum inerme HAECKEL	(YAMAZI, 1959, p. 47)
Cromyomma sp.	(YAMAZI, 1959, p. 174)
Diploconcus sp.	(IKARI, MS)
Drymosphaera polygonalis HAECKEL	(YAMAZI, 1959, p. 174)
Eusyringium sp.	(IKARI, MS.)
Gazelletta hexanema HAECKEL	
Gazelletta sp.	
Heliocladus sp.	(YAMAZI, 1959, p. 175)
Hexalonche sp.	(YAMAZI, 1959, p. 174)
Lychnocanium sp.	(YAMAZI, 1959, p. 202)
Lithophyllium sp.	(IKARI, MS.)
Octopyle sp.	(IKARI, MS.)
Polysolenia sp.	(YAMAZI, 1959, p. 202)

Pterocanium sp.	
Sphaerozoum geminatum Haeckel	(Yamazi, 1959, p. 46)
Sphaerozoum sp.	(Ikari, MS.)
Staurocantha sp.	(Yamazi, 1959, p. 175)
Staurosphaera sp.	(Yamazi, 1959, p. 174)
Tetraspyris sp.	(Ikari, MS.)
Trizone brandti Pop.	(Yamazi, 1959, p. 175)
Zonidium sp.	(Yamazi, 1959, p. 202)

Order HELIOZOA

Sticholonche zanclea (O. Schröder)

Very abundant, in the inner part of the inlet, throughout the year, especially in spring and autumn. Neritic and littoral, ubiquitous species. (Yamazi, 1959, p. 26, 212)

Class **CILIOPHORA**

Subclass *CILIATA*

Order HOLOTRICHA

Suborder *TINTINNOINEA*

Family 1. Tintinnidae

Leptotintinnus nordqvisti (Brandt)

Rare, inside and outside the bay, from early summer to autumn. Neritic, warm-water species. In October (Ikari, MS.)

Family 2. Codonellidae

Codonella inflata Kofoid et Campbell

Warm water species. Found in September (Ikari, MS.)

Tintinnopsis aperta var. **tocantinensis** Kofoid et Campbell

Rare, inside the bay, in warm seasons. Neritic, warm-water species. In October (Ikari, MS.)

Tintinnopsis beroidea Stein

Very common, throughout the year, especially in spring and summer. Neritic, eurythermal, from tropical to boreal. (Yamazi, 1959, p. 129)

Tintinnopsis cylindrica Daday

Common, inside the inlet, in summer season. Neritic, warm-water form.

Tintinnopsis gracilis Kofoid et Campbell

Rare, inside the inlet, in summer. Neritic, warm-water form. (Yamazi, 1959, p. 129)

Tintinnopsis karajacensis Brandt

Rare, inside and outside the bay, in warm seasons. Neritic, warm-water species. In September. (Ikari, MS.)

Tintinnopsis mortensenii SCHMIDT

Rare, found occasionally in summer and spring. Neritic, warm-water species. (YAMAZI, 1959, p. 129)

Tintinnopsis radix (IMHOF)

Very common, at sometimes in swarms, in the innermost part of the bay. Neritic, stenothermal, warm-water form. (YAMAZI, 1959, p. 128, 129)

Tintinnopsis tubulosa LEVANDER

Very rare, in winter and spring. Neritic, cold-water species.

Family 3. Codonellopsidae

Codonellopsis morchella (CLEVE)

Very rare, found occasionally throughout the year. Neritic, eurythermal from tropical to boreal. (YAMAZI, 1959, p. 176). In September (IKARI, MS.)

Codonellopsis nipponica HADA

Very rare, neritic, warm water form.

Codonellopsis parva KOFOID et CAMPBELL

Rare, in summer, oceanic, warm-water species. (YAMAZI, 1959, p. 176, 202). In September (IKARI, MS.)

Codonellopsis ostenfeldi (SCHMIDT)

Very rare, neritic, warm-water species.

Stenosemella nivalis (MEUNIER)

Rare, all the year round, in inlet area. Neritic, eurythermal, from tropical to boreal. In September. (IKARI, MS.)

Family 4. Coxliellidae

Coxliella ampula (JÖRGENSEN)

Very rare, in cold seasons, inside the inlet. Neritic, widespread species. In March. (IKARI, MS.)

Coxliella longa (BRANDT)

Oceanic, warm-water species. In September. (IKARI, MS.)

Helicostomella subulata (EHRENBERG)

Very rare, outside and inside the bay, in winter and spring. Widely distributed, cold-water species. In March. (IKARI, MS.)

Helicostomella longa (BRANDT)

Fairly common, in the innermost part, in spring and summer. Neritic, warm-water species. In September (IKARI, MS.)

Family 5. Cyttarocylidae

Cyttarocylis acutiformis KOFOID et CAMPBELL

Very rare, outside, in summer. Oceanic, warm-water species. In November. (IKARI, MS.)

Cyttarocylis brandti KOFOID et CAMPBELL

Very rare, outside the bay, in summer.

Favella azorica (CLEVE)

Rare, occasionally found in the bay. Widespread, neritic. Tropical warm-water species.

Favella ehrenbergii CLAPARÉDE et LACHMANN

Common in the inlet, summer and autumn. Neritic, warm-water species.

Favella taraikaensis HADA

Very common, in the inner part of the bay, late spring and summer. Widespread. Neritic, temperate species. (YAMAZI, 1959, p. 56, 103, 129)

Poroecus apiculatus (CLEVE)

Very common, inside, in early summer. Neritic, warm-water species.

Family 6. Ptychocylidae

Epiplocylis calyx (BRANDT)

Very rare, in open sea water. Oceanic tropical species. In November. (IKARI, MS.)

Epiplocylis undella (OSTENFELD et SCHMIDT)

Very rare, inside and outside the inlet, especially, in summer. Oceanic, tropical warm-water species.

Epiplocylis undella constricta KOFOID et CAMPBELL

Very rare, in open sea water near the mouth. Oceanic, warm-water species. (YAMAZI, 1959, p. 202). In September (IKARI, MS.)

Epiplocyloides lata KOFOID et CAMPBELL

Very rare, found in open water outside the bay, in summer. In November. (IKARI, MS.) Oceanic, tropical warm-water species.

Family 7. Petalotrichidae

Metacylis corbula KOFOID et CAMPBELL

Very rare. In September (IKARI, MS.)

Metacylis mediterranea (MERESCHKOWSKY)

Very rare, found in open water, summer and autumn. Oceanic, tropical warm-water species.

Petalotricha ampulla (FOL)

Oceanic, tropical warm-water species. In October. (IKARI, MS.)

Family 8. Rhabdonellidae

Protorhabdonella simplex (CLEVE)

Warm-water species.

Rhabdonella amor (CLEVE)

Oceanic. In October. (IKARI, MS.)

Rhabdonella elegans JÖRGENSEN

Very rare, in the open sea water outside the inlet, in warm seasons. Oceanic, warm-water species. In October. (IKARI, MS.)

Rhabdonella poculum (OSTENFELD et SCHMIDT)

Very rare. Oceanic, warm-water species.

Rhabdonellopsis apophysata (CLEVE)

Very rare, open sea water, in summer. Oceanic, warm-water species. In July. (IKARI, MS.)

Family 9. Xystonellidae

Xystonellopsis heros (CLEVE)

Very rare. Oceanic, warm-water species (YAMAZI, 1959, p. 176). In October. (IKARI, MS.)

Xystonella scandens (BRANDT)

Oceanic. In November. (IKARI, MS.)

Xystonella treforti (DADAY)

Oceanic, warm-water species.

Family 10. Undellidae

Undella (=Proplectella) **claparédei** (ENTZ.)

Very rare, tropical, warm-water species. In October. (IKARI, MS.)

Undella californiensis KOFOID et CAMPBELL

Very rare, inside and outside the bay, in cold seasons. Stenothermal, north-temperate species.

Family 11. Dictyocystidae

Dictyocysta reticulata KOFOID et CAMPBELL

Very rare, outside the inlet, in summer. Oceanic, warm-water species.

Family 12. Tintinnidae

Amphorella quadrilineata (CLAP. et LACHMANN)

Rare, inside and outside, in winter and spring. Neritic, ubiquitous, eurythermal form, tropical to boreal.

Amphorellopsis acuta (SCHMIDT)

Very rare, occasionally found in summer. Oceanic, warm-water species.

Dadayiella bulbosa (BRANDT)

Very rare, found in summer. Oceanic, warm-water species.

Dadayiella ganimedes (ENTZ.)

Very rare, found in summer. Oceanic, warm-water species. In September. (IKARI, MS.)

Salpingella acuminata (CLAPARÉDE & LACHMANN)

Rare, inside and outside, in spring and summer. Eurythermal, from tropical to-boreal. In November. (IKARI, MS.)

Steenstrupiella steenstrupi (CLAPARÉDE & LACHMANN)

Very rare, in summer. Oceanic, warm-water species. In November. (IKARI, MS.)

Tintinnus exiguus HADA

Rare, all the year round, but in early summer and spring. Stenothermal, north-temperate species.

Tintinnus fraknoii DADAY

Very rare, in summer. Tropical, warm-water species.

Tintinnus lusus-undae ENTZ.

Common but not abundant, in all seasons, especially in summer. Neritic, warm-water species.

Tintinnus lusus-undae var. **tenuis** KOFOID & CAMPBELL

Neritic, warm-water species.

Tintinnus rectus WOLFES

Very rare, inside and outside the bay, in cold seasons. Stenothermal, temperate species. (YAMAZI, 1959, p. 176). In February. (IKARI, MS.)

Phylum **COELENTERATA**

Subphylum *CNIDARIA*

Class **HYDROZOA**

Order HYDROMEDUSAE

Suborder *ANTHOMEDUSAE*

Bougainvillia bitentaculata UCHIDA

Found in early summer, rare, neritic.

Cladonema radiatum var. **Mayeri** PERKINS

From early summer to late summer, neritic, common.

Cytaeis japonica UCHIDA

Common in early summer. (KOMAI, 1931, p. 252)

Dipurena ophigaster HAECKEL

Summer, found almost everywhere, temperate specices, rare.

Euphysa bigelowi (MAAS)

Summer, found everywhere, warm-water species, rare.

Gotoea typica UCHIDA

In spring and early summer, rare.

Halitiaria formosa FEWKES

Rare, in late summer, in the bay.

Hybocodon forbesii MAYER

Rare, in late summer, in the bay.

Leuckartiaria octona (FLEMING)

HIRO (1939, p. 170)

Nemopsis dofleini MAAS

Common, in spring, in the outer and inner part of the inlet.

Podocoryne simplex KRAMP

In summer, common.

Proboscidactyla ornata BROWN

Rare, inside the bay.

Proboscidactyla ornata var. **gemmifera** MAAS

In summer, almost everywhere, rare. (YAMAZI, 1959, p. 131)

Proboscidactyla typica (UCHIDA) 〔=*Misakia typica* UCHIDA〕

Rare, in early summer.

Rathkea octopunctata (SARS)

Rare, from winter to spring.

Sarsia nipponica UCHIDA

Rare, in late autumn, neritic. Warm-water species.

Spirocodon saltatrix (TILESIUS)

From winter to early summer, common inlet waters.

Stomotoca rugosa MAYER

Rare, in winter and early spring, neritic.

Tiaranna ikarii UCHIDA

Rare, in autumn.

Turritopsis nutricula McCRADY

Rare, in summer, anywhere in the bay.

Suborder *LEPTOMEDUSAE*

Aequorea coerulescens BRANDT

In spring and early summer, common inside the bay.

Eucheilota paradoxica MAYER

In summer, rare, near the mouth.

Eutima japonica UCHIDA

In summer season, inner part of the bay.

Gastroblasta chenghanensis LING

Common, in spring and early summer. Neritic form. (KOMAI et YAMAZI, 1944; YAMAZI, 1959, p. 131)

Irenopsis hexanemalis GOETTE

Very common, in inner part of the bay, in warm seasons.

Obelia sp. 1

Very common in spring and early summer. Neritic form (YAMAZI, 1959, p. 30, 131)

Obelia sp. 2

Order TRACHYLINA

Suborder *TRACHOMEDUSAE*

Aegina rosea ESCHSCHOLTZ

In winter and early spring. Common, almost anywhere in the inlet.

Aglaura hemistoma PÉRON et LESUEUR

From spring to summer, warm-water form. (YAMAZI, 1959, p. 30)

Geryonia proboscidalis FORSKÅL

In winter season, rarely found in the bay.

Liriope tetraphylla CHAMISSO et EYSENHARDT

Common, in autumn and winter. At times in swarms. (YAMAZI, 1959, p. 130)

Rhopalonema velatum GEGENBAUR

In common in the inlet waters.

Solmaris corona HAECKEL

Common in winter and spring, almost anywhere. (YAMAZI, 1959, p. 131)

Solmundella bitentaculata QUOY et GAIMARD

Common in spring and summer season. Oceanic, warm-water form. (YAMAZI, 1959, p. 130)

Suborder *LIMNOMEDUSAE*

Gonionemus depressus GOTO

Very rare, in early summer, lodged on *Zostera*.

Olindias formosus (GOTO)

Common, in early summer, inside and outside the bay. (YAMAZI, 1959, p. 131)

Scolionema gemmifera KISHINOUYE

In spring and early summer, off Ezura. Very common. Lodged on *Zostera*.

Order SIPHONOPHORA

Suborder *CALYCOPHORAE*

Abylopsis tetragona (OTTO)

Very common in our waters, in winter and spring.

Diphyes bojani (ESCHSCHOLTZ)

Common in the outer part of the inlet, in spring and early summer. (YAMAZI, 1959, p. 177)

Diphyes chamissonis HUXLEY

Rare, in the bay, in spring and early summer. Warm-water form.

Diphyes contorta LENS et VAN RIEMSDIJK

Rare, in open sea water near the mouth, in spring season. (YAMAZI, 1959, p. 178)

Diphyes dispar CHAMISSO et EYSENHARDT

Rare, in the bay, in spring and early summer. Warm-water form. (YAMAZI, 1959, p. 54, 178)

Hippodius ungulatus HAECKEL

Rare in our waters, in spring.

Muggiaea atlantica CUNNINGHAM

Very common, in almost all seasons, especially in winter. Eurythermal species. (YAMAZI, 1959, p. 178)

Muggiaea spiralis (BIGELOW)

Common, in winter and spring seasons, in open sea water. (YAMAZI, 1959, p. 177)

Praya cymbiformis DELLE CHIAJE

Rare, in the open-sea water near the mouth, in spring and early summer. Oceanic, warm-water form.

Suborder *PHYSOPHORAE*

Agalma elegans (SARS)

Rare, found in spring and early summer. Warm-water form.

Nanomia bijuga (DELLE CHIAJE) [=*Cupulita picta* CHUN]

Rare in the bay, occasionally found in spring season. Oceanic, warm-water form.

Physophora hydrostatica FORSKÅL

Rare in the bay, in spring. Warm-water form.

Suborder *CYSTONECTAE*

Physalia physalis utriculus LA MARTINIERE

Occasionally common, especially in summer, drifted ashore. (YAMAZI, 1959, color pl. 1.)

Rhizophysa eysenhardtii GEGENBAUR

Rare, in spring season.

Rhizophysa filiformis (FORSKÅL)

Rare near shore, in open water near the mouth, in spring.

Suborder *DISCONECTAE*

Porpita porpita (LINNÉ) [=*P. umbella* O. F. MÜLLER]

Very common in late spring and early summer. Sometimes in swarms, drifted ashore. (YAMAZI, 1959, p. 30)

Velella velella (LINNÉ) [=*V. lata* CHAMISSO et EYSENHARDT]

At times very common, drifted ashore, in late spring and summer.

Class **SCYPHOMEDUSAE** (SCYPHOZOA)

Order CUBOMEDUSAE

Charybdea rastoni HAECKEL

Common in summer and autumn.

Tamoya bursalis HAECKEL [=*T. alata* RAYNAUD; *T. virlenta* KISHINOUYE]

Rather rare, sometimes in swarms, in late summer and autumn. Known as a stinging medusa. (UCHIDA, 1926)

Order CORONATAE

Nausithoë punctata KÖLLIKER

Common in winter and spring. Scyphopolype named "*Stephanoscyphus racemosus* Komai" are common on submerged rocks along an islet Tôsima in front of the Laboratory. (UCHIDA, 1926; KOMAI, 1935)

Order SEMAEOSTOMAE

Aurellia aurita (LINNÉ) LAMARCK

Most abundant in the inner part of the bay, in spring and summer. Ephyrae appear in aquarium. (UCHIDA, 1926; OKADA, 1949, p. 355; YAMAZI, 1959, p. 60)

Cyanea nozakii KISHINOUYE

Rare in the bay, in winter.

Dactylometra pacifica GOETTE (=*D. ferruginaster*; *D. longicirra*)

Very common in the bay, in spring and early summer. (UCHIDA, 1926)

Pelagia panopyra PÉRON et LESUEUR

Fairly common near the mouth of the bay, in spring and early summer. Warm current form. (UCHIDA, 1926)

Sanderia malayensis GOETTE

Common in summer. Warm-water form. (UCHIDA, 1926)

Order RHIZOSTOMAE

Cephea cephea (FORSKÅL)

Very rare, in open sea water near the mouth of the bay, in autumn. Warm-water form.

Mastigias papua L. AGASSIZ

Very common, in the inner part of the bay, in autumn. Inlet warm-water form. (YAMAZI, 1959, color pl. 1.)

Netrostoma setouchiana KISHINOUYE

Rare in the bay, occasionally in autumn, in coastal waters. (UCHIDA, 1926)

Class ANTHOZOA

Order ZOANTHARIA

Suborder *ACTINIARIA*

Boceroides mcmurrichi (KWIETNIEWSKI)

Common, near the shore found throughout the year.

Subphylum *CTENOPHORA*

Order CYDIPPIDEA

Euchlora rubra (KÖLLIKER)

Very rare. (KOMAI et TOKIOKA, 1942)

Hormiphora palmata CHUN

Rare, in the outer part of the bay, in spring and early summer.

Pleurobrachia pileus VANHÖFFEN

Very rare, in spring, in the mouth. (YAMAZI, 1959, p. 60, 123)

Order LOBATEA

Bolinopsis mikado (MOSER)

Common in the coastal waters, in spring season, sometimes very abundant.

Eurhamphaea vexilligera GEGENBAUR

Very rare. (KOMAI et TOKIOKA, 1942)

Kiyohimea aurita KOMAI et TOKIOKA

Very rare, found only in winter. (KOMAI et TOKIOKA, 1940)

Leucothea japonica KOMAI

Abundant in the bay, in winter and spring.

Ocyropsis fusca (RANG)

Rare, sometimes in swarms, in spring season.

Order CESTIDEA

Cestum amphitrites MERTENS

Very rare in the bay, in spring season.

Order BEROIDEA

Beroë cucumis FABRICIUS

Very common, inside the bay, occasionally very abundant, in spring and early summer.

Phylum ASCELMINTHES

Class ROTIFERA

Encentrum sp.

Common but never abundant, in the inner part of the bay, early summer. Neritic and littoral form. (YAMAZI, 1959, p. 103)

Synchaeta sp.

Rarely found, inside the bay, chiefly in spring and summer. Neritic and littoral species.

Phylum ANNELIDA

Class CHAETOPODA

Alciopa cantrainii DELLE CHIAJE

Very rare, in summer, near the mouth of the bay.

Autolitus sp.

Very rare, in summer, near the mouth of the bay.

Rhynchonerella fulgens GREEFF

Very rare, in summer.

Sagitella kowalewskii N. WAGNER

Very rare, in summer. Warm-water form.

Tomopteris elegans CHUN

Very rare, found occasionally in summer, in open sea water outside the bay. Oceanic, warm-water form. (YAMAZI, 1959, p. 110, 120)

Tomopteris pacifica IZUKA

Very rare, oceanic, warm-water form.

Tomopteris septentrionalis DE QUATREFAGES

Very rare, oceanic, warm-water form.

Tomopteris sp.

Rare, found in warm seasons. Oceanic, warm-water form.

Typhloscolex Mülleri BUSCH

Very rare, found in warm season, near the mouth of the bay.

Typhloscolex sp. 1

Typhloscolex sp. 1

Vanadis grandis IZUKA

Pelagic polychaete sp. 1

Pelagic polychaete sp. 2

Pelagic polychaete sp. 3

Pelagic polychaete sp. 4

Pelagic polychaete sp. 5

Pelagic polychaete sp. 6

Phylum CHAETOGNATHA

Eukrohnia hamata (MÖBIUS)

Very rare, in the outer part of the bay. Oceanic, warm-water form. (YAMAZI, 1959, p. 211)

Krohnitta pacifica (AIDA)

Very rare, in Feburary. (TOKIOKA, 1954)

Pterosagitta draco (KROHN)

Very rare, in the inlet, but sometimes common in early spring in front of the Laboratory. (YAMAZI, 1959, p. 190). Found in winter (TOKIOKA, 1954).

Sagitta bedoti BÉRANECK

Very common in the bay, especially the outer parts, in summer. Oceanic, tropical species. (YAMAZI, 1959, p. 190)

Sagitta bipunctata QUOY et GAIMARD

Oceanic, subtropical and temperate species. (YAMAZI, 1959, p. 192)

Sagitta delicata TOKIOKA

Very common, in the inner part of the bay, throughout the year, especially in summer. Neritic and littoral, south-temperate species. (YAMAZI, 1959, p. 58, 126)

Sagitta enflata GRASSI

Very common, in the open sea water out of the bay, in almost all seasons. Oceanic, tropical species. (TOKIOKA, 1954; YAMAZI, 1959, p. 57, 110, 191)

Sagitta hexaptera KROHN

Rare, outside the bay, in spring and summer. Oceanic, subtropical and temperate species.

Sagitta lyra KROHN

Common, in the bay, from late spring to autumn. Oceanic, warm-water form. (YAMAZI, 1959, p. 190). In early summer relatively common. (TOKIOKA, 1954)

Sagitta minima GRASSI

Very common, in warm seasons. Oceanic, south-temperate species. (YAMAZI, 1959, p. 192) Common in spring. (TOKIOKA, 1954)

Sagitta neglecta AIDA

Rare, occasionally abundant, in warm seasons. Oceanic, warm water-species. (YAMAZI, 1959, p. 193)

Sagitta regularis AIDA

Common in open sea water near the mouth, in spring and summer. Oceanic, warm-water species. (YAMAZI, 1959, p. 193)

Sagitta robusta DONCASTER

Rare, near the mouth, in warm season, oceanic, tropical species. (YAMAZI, 1959, p. 193)

Sagitta serratodentata atlantica f. **pseudoserratodentata** TOKIOKA

Rare, in the bay, in warm season. Oceanic, warm-water species. Very rare, in February. (TOKIOKA, 1954)

Sagitta serratodentata pacifica KROHN

Very common, in the bay, in warm season, oceanic, warm-water form (YAMAZI, 1959, p. 191). Very abundant in early spring (TOKIOKA, 1954).

Spadella cephaloptera (BUSCH)

Rare, in February (TOKIOKA, 1954).

Phylum **MOLLUSCA**

Class **GASTROPODA**

Subclass *PROSOBRANCHIA*

Order PTENOGLOSSA

Ianthina janthina (LINNÉ)

Commonly drifted ashore in summer and autumn. Oceanic, warm-water form. (YAMAZI, 1959, p. 55)

Ianthina prolongata BLAINVILLE [=*I. globosa* SWAINSON]

Commonly drifted ashore, in summer. (YAMAZI, 1959, p. 55)

Ianthina umbilicata D'ORBIGNY

Very commonly drifted ashore in summer and autumn. Oceanic, warm-water form. (YAMAZI, 1959, p. 50)

Peraclis reticulata (D'ORBIGNY)

Very rarely drifted ashore, in warm season. Oceanic, warm-water form. (YAMAZI, 1959, p. 50)

Recluzia montrouzieri BRAZIER

Rarely drifted ashore, in warm season. Oceanic, warm-water form. (TOKIOKA, 1953, p. 57)

Section Heteropoda

Atlanta gaudichaudi SOULEYET

Rare, often in tow-netting. Oceanic, warm-water form.

Atlanta inclinata SOULEYET

Very rare, often in tow-netting. Oceanic, warm water-form.

Atlanta lesueuri SOULEYET [=*A. oligogyra* TESCH]

Very rare, found in warm season. Oceanic, warm-water form.

Atlanta pacifica TOKIOKA

Very rare, found occasionally in tow-netting. Oceanic, warm-water form.

Atlanta peroni LESUEUR

Rarely found in the inlet. Oceanic, warm water form.

Carinaria cristata (LINNÉ)

Rare, found in tow-netting, in warm season, very rarely drifted ashore.

Firoloida desmaresti LESUEUR [=*F. kowalewskyi* VAYSSIÈRE]

Very rarely drifted ashore in front of the Laboratory. (YAMAZI, 1959, p. 184)

Oxygyrus keraudreni (LESUEUR)

Very rarely drifted ashore.

Pterotrachea coronata FORSKÅL [=*P. challengeri* TESCH]

Very rarely drifted ashore. Oceanic, warm-water form. (YAMAZI, 1959, p. 58)

Subclass *OPISTHOBRANCHIA*

Order NUDIBRANCHIA

Cephalopyge orientalis BABA

One specimen was found by Mr. Y. MIYASITA. (BABA, 1933)

Order PTEROPODA

Cavolina columnella columnella (RANG)

Very rare, drifted ashore. Oceanic, warm-water form.

Cavolina gibbosa gibbosa (RANG)

Very rare, drifted ashore. Oceanic, warm-water form.

Cavolina globulosa (RANG)

Very rare. Oceanic, warm water form.

Cavolina inflexa labiata (D'ORBIGNY)

Rare, drifted ashore. Oceanic, warm-water form. (YAMAZI, 1959, p. 50)

Cavolina longirostris longirostris (LESUEUR)

Rare occasionally in swarms, in summer and autumn. Oceaic, warm-water form. (YAMAZI, 1959, p. 186)

Cavolina quadridentata (LESUEUR)

Rare, occasionally in swarms but not abundant, in summer. Oceanic warm-water form. (YAMAZI, 1959, p. 186)

Cavolina tridentata (FORSKÅL)

Very rare, occasionally in swarms. Oceanic, warm water form. (YAMAZI, 1959, p. 185)

Cavolina uncinata (RANG)

Rare, in open sea water near the mouth of the bay. Oceanic, warm-water form. (YAMAZI, 1959, p. 186)

Clio pyramidata lanceolata TESCH

Occasionally found in swarms, but not abundant, in late spring and summer. Oceanic, warm-water form. (YAMAZI, 1959, p. 51)

Creseis acicula acicula RANG

Common in our region, occasionally very abundant in summer. Oceanic, warm-water form. (YAMAZI, 1959, p. 122, 189)

Creseis acicula clava RANG

Common, oceanic, warm-water form.

Creseis virgula conica (ESCHSCHOLTZ)

Rare, in summer. Oceanic, warm-water form. (YAMAZI, 1959, p. 51, 189)

Creseis virgula virgula RANG

Occasionally common, in late spring to summer. (YAMAZI, 1959, p. 51, 189) Oceanic, warm-water form.

Desmopterus papilio CHUN

Rare, in open water near the mouth, in almost all seasons, especially in summer. Oceanic, warm-water species.

Diacria quadridentata (LESUEUR)

Very rare. Oceanic, warm-water form. Young form is *Cleodora pigmaeus* BOAS.

Diacria trispinosa (LESUEUR)

Very rare, found occasionally in open sea water near the mouth of the bay. Oceanic, warm-water form. Young form is *Cleodora compressa* SOULEYET. (YAMAZI, 1959, p. 185)

Hyalaea complanata GEGENBAUR

Young form of *Cav. tridentata tridentata* FORSKÅL.

Hyalaea depressa TESCH

Young form of *Cav. inflexa labiata* (D'ORBIGNY). Rare, in open sea water near the mouth of the bay. (YAMAZI, 1959, p. 187)

Hyalaea laevigata D'ORBIGNY

Larval form of *Cav. longirostris longirostris* (LESSON). (YAMAZI, 1959, p. 187)

Hyalaea rotundata BOAS

Larval form of *Cav. globulosa* (RANG).

Hyalocylix striata (RANG)

Very rare, occasionally drifted ashore in front of the Laboratory. (YAMAZI, 1959, p. 188)

Limacina trochiformis (D'ORBIGNY)

Very rare, in warm season.

Styliola subula QUOY et GAIMARD

Rare, found occasionally in open sea waters near the mouth of the bay. Oceanic, warm-water form. (YAMAZI, 1959, p. 188)

Phylum **ARTHROPODA**

Class **CRUSTACEA**

Subclass *BRANCHIOPODA*

Order CLADOCERA

Evadne nordmanni LOVÉN

Very common, almost anywhere from winter to early summer. Neritic species. Widely distributed form.

Evadne tergestina CLAUS

Very common almost anywhere, especially in the inner part of the bay. Neritic and littoral form. (YAMAZI, 1959, p. 65, 127)

Penilia schmackeri RICHARD

Very common, almost anywhere, in winter and early summer. Neritic and littoral, warm-water form. (YAMAZI, 1959, p. 65, 127)

Podon leuckarti G. O. SARS

Rare, almost anywhere, in early summer. Neritic and littoral form. (YAMAZI, 1959, p: 127)

Podon polyhemoides (LEUCKART)

Common, almost anywhere in the bay, in early summer. Neritic and littoral form. (YAMAZI, 1959, p. 65)

Subclass *OSTRACODA*

Family 1. Halocypridae

Conchoecia hamata VÉVRA

Found in open sea water near the mouth of the bay. Oceanic form. (YAMAZI, 1959, p. 182)

Conchoecia sp. 1

Conchoecia sp. 2

Conchoecia sp. 3

Conchoecia sp. 4

Conchoecia sp. 5

Conchoecia sp. 6

Conchoecia sp. 7

Conchoecia sp. 8

Conchoecia sp. 9

Conchoecia sp. 10

Euconchoecia sp.

Rare, in open sea water near the mouth of the bay. Oceanic form. (YAMAZI, 1959, p. 182)

Family 2. Cypridinidae

Cylindroleberis oblonga (GRUBE)

Rare, near the coast. Tichopelagic form.

Cylindroleberis ovalis KAJIYAMA

Rare, near the coast. Tichopelagic form.

Cylindroleberis sp.

Rare, around the coast. Tichopelagic form.

Cypridina hilgendorfi G. W. MÜLLER

Rare, all round the coast. Tichopelagic form.

Cypridina noctiluca KAJIYAMA

Very common, all round the coast. Tichopelagic form. (YAMAZI, 1959, p. 118, 143)

Cypridina pellucida KAJIYAMA

Very rare, all round the coast. Tichopelagic form.

Cypridina sp. 1

Tichopelagic form. All the year round, near the coast.

Cypridina sp. 2

Tichopelagic form. All the year round, near the coast.

Philomedes ijimai KAJIYAMA

Tichopelagic form, coming up to the surface at night. (YAMAZI, 1959, p. 143)

Subclass *COPEPODA*

Order EUCOPEPODA

Suborder *CALANOIDA* (*GYMNOPLEA*)

Family 1. Calanidae

Calanus finmarchicus (GUNNERUS) [=*C. helgolandicus* (CLAUS)]

Common, throughout the year, especially in early summer and autumn, outside the inlet. Widespread species. (YAMAZI, 1959, p. 68, 107, 111, 115)

Calanus minor (CLAUS)

Rare, in open sea water near the mouth of the bay, in summer and autumn. Warm-water species.

Calanus tenuicornis (DANA)

Rare, in open sea water near the mouth of the bay, in summer. Oceanic, subtropical and south-temperate form.

Canthocalanus pauper (GIESBRECHT)

Common near the mouth, in all seasons, especially in warm season. Oceanic, tropical and subtropical species.

Neocalanus gracilis (DANA)

Very rare, in open sea water near the mouth of the bay, in summer and autumn. Oceanic, warm-water species.

Neocalanus robustior (GIESBRECHT)

Rather rare, in open sea water near the mouth of the bay, in summer. Warm-water species.

Undinula darwini (LUBBOCK)

Rare, near the mouth of the bay, more or less common in warm season. Oceanic, tropical species.

Undinula vulgaris (DANA)

Rare, in open sea water near the mouth of the bay, in warm season. Tropical, warm-water form.

Family 2. Eucalanidae

Eucalanus attenuatus (DANA)

Commonly throughout the year, especially in warm seasons. Oceanic, tropical and subtropical form. (YAMAZI, 1959, p. 107)

Eucalanus crassus GIESBRECHT

Rare, at the mouth, in summer and autumn. Oceanic, warm-current form.

Eucalanus elongatus (DANA)

Very rare, at the mouth of the bay, in spring and early summer. Oceanic, north-temperate species.

Eucalanus mucronatus GIESBRECHT

Rare, near the mouth, in summer. Oceanic, warm-water species.

Eucalanus subcrassus GIESBRECHT

Very rare, outside and inside the bay, in warm seasons. Oceanic, tropical species.

Eucalanus sp.

Mecynocera clausi THOMPSON

Not common in open sea water outside the bay, in warm seasons. (YAMAZI, 1959, p. 184)

Rhincalanus cornutus DANA

More or less common in open sea, especially in warm seasons. Oceanic, tropical and subtropical form.

Rhincalanus nasutus GIESBRECHT

Very rare, off Tanabe, in summer season. Oceanic, warm-water species.

Family 3. Paracalanidae

Acrocalanus gibber GIESBRECHT

Very rare outside the bay, in warm season. Oceanic, warm-water species.

Acrocalanus gracilis GIESBRECHT

More or less common, in open sea waters, in warm season. Oceanic, warm-water species.

Acrocalanus longicornis GIESBRECHT

Very rare, in open sea water, in summer and autumn. Oceanic, warm-water form.

Calocalanus pavo (DANA)

Rare, in open sea water, in summer season. Oceanic, tropical species. (YAMAZI, 1959, p. 107, color pl. 2.)

Calocalanus plumulosus (CLAUS)

Very rare, in open sea water, in summer season. Oceanic, tropical species.

Calocalanus styliremis GIESBRECHT

Very rare, in open sea water, in summer and autumn. Oceanic, tropical species.

Paracalanus aculeatus GIESBRECHT

Fairly frequent in open sea water outside the bay, in warm season. Oceanic, tropical and subtropical form.

Paracalanus parvus GIESBRECHT

Most abundant. The minor form inside the inlet, especially in warm season, while the major form outside the inlet, in warm season widely distributed, from oceanic and neritic to littoral, eurythermal species. (YAMAZI, 1959, p. 111, 125)

Family 4. Pseudocalanidae

Clausocalanus arcuicornis (DANA)

Very rare, in open sea water, in summer and autumn. Oceanic, warm-water species.

Clausocalanus pergens FARRAN

Very rare, in open sea water near the mouth, in summer. Oceanic warm-water species.

Family 5. Aetideidae

Aetideus armatus (BOECK)

Very rare, in open sea water, in warm season. Oceanic, tropical and subtropical species.

Aetideus giesbrechti CLEVE

Very rare, in open sea water near the mouth, in summer. Oceanic, tropical and subtropical species.

Euchirella amoena GIESBRECHT

Very rare, in open water, in warm season. Oceanic, warm-water species.

Euchirella rostrata GIESBRECHT

Very rare, in open sea water near the mouth, in warm season. Oceanic, warm-water form.

Euchirella sp.

Family 6. Euchaetidae

Euchaeta flava GIESBRECHT

Very rare, outside, in warm season. Temperate species. (YAMAZI, 1959, color pl. 2)

Euchaeta marina PRESTENDREA

Very common in all seasons, especially in warm season. (YAMAZI, 1959, p. 108)

Euchaeta plana Mori

Very rare, outside, in warm season. Oceanic, warm-water form.

Euchaeta wolfendeni A. Scott

Very rare, in warm season. Oceanic, tropical and subtropical species.

Euchaeta sp. 1

Euchaeta sp. 2

Family 7. Phaennidae

Phaenna spinifera Claus

Very rare, in open water, in summer. Oceanic, tropical and subtropical form.

Family 8. Scolecithriciidae

Scolecithrix danae (Lubbock)

Fairly common, near the mouth, in warm seasons.

Family 9. Centropagidae

Centropages abdominalis Sato

Rare, inside the inlet, in winter and early spring. Neritic, north-temperate species.

Centropages bradyi Wheeler

Very rare, inside and outside the bay, in winter and early summer. North-temperate species.

Centropages calaninus (Dana)

Rare, outside the bay, in summer season. Oceanic, warm-water form.

Centropages elongatus Giesbrecht

Very rare, outside, in warm season. Warm-water species.

Centropages furcatus (Dana)

Rare, Oceanic, frequently neritic. Widely distributed, warm-water form.

Centropages gracilis (Dana)

Rare, in open sea water, in warm season.

Centropages orsinii Giesbrecht

Rare, inside and outside the bay, in summer. Warm-water species.

Centropages yamadai Mori [=*C. tenuiremis* Thompson & Scott]

Rare, in the inlet, in autumn and spring. Temperate species.

Centropages sp. 1

Centropages sp. 2

Family 10. Diaptomidae

Pseudodiaptomus marinus Sato

Fairy common in the inlet, in winter and early summer, neritic. (Yamazi, 1959, p. 111, 115)

Family 11. Temoridae

Temora discaudata Giesbrecht

Fairly common inside and outside the bay, in warm water season. South-temperate and subtropical species.

Temora stylifera (Dana)

Very rare, outside the inlet, in summer and autumn. Oceanic, subtropical species.

Temora turbinata (Dana)

Very rare, in open sea waters, in summer and autumn. Oceanic, south-temperate species.

Family 12. Metriidae

Pleuromamma abdominalis (Lubbock)

Very rare, outside the inlet, in warm season. Oceanic, southern warm-water form. (Yamazi, 1959, p. 121)

Pleuromamma gracilis (Claus)

Very rare, southern temperate species.

Pleuromamma robusta Giesbrecht

Very rare, in open sea water, in warm season, Oceanic, southern warm-water form.

Pleuromamma xiphias Giesbrecht

Very, rare, southern warm-water form.

Family 13. Lucicutiidae

Lucicutia flavicornis (Claus)

Very rare. Oceanic, warm-water form.

Lucicutia ovalis Wolfenden

Very rare, in open sea water, in warm season. Oceanic, warm-water form.

Lucicutia sp.

Family 14. Heterorhabdidae

Heterorhabdus papilliger (Claus)

Very rare, in summer and autumn. Oceanic, warm-water form.

Family 15. Augaptilidae

Haloptilus acutifrons (Giesbrecht)

Very rare, oceanic warm-current species, in summer and autumn.

Haloptilus longicornis (Claus)

Very rare, in summer and autumn. Oceanic, warm-current species.

Haloptilus mucronatus (Claus)

Very rare, in summe. Oceanic, warm-current species.

Haloptilus oxycephalus (GIESBRECHT)

Very rare, in summer and autumn. Oceanic, warm-current form.

Family 16. Candaciidae

Candacia aethiopia (DANA)

Very rare, in open water, in summer. Oceanic, warm-current form.

Candacia armata (BOECK)

Rare, in open sea water near the mouth, in summer and autumn. Warm-current form.

Candacia bispinosa (CLAUS)

Rare, in open sea water near the mouth, in summer. Oceanic, warm-water form.

Candacia bipinnata (GIESBRECHT)

Rare, outside and inside the bay, in spring and early summer. North-temperate species.

Candacia bradyi A. SCOTT

Very rare, outside the bay, in summer. Oceanic, warm-water species.

Candacia catula (GIESBRECHT)

Very rare, at the mouth, in summer. Oceanic, tropical warm-current species.

Candacia curta (DANA)

Very rare, in open sea water near the mouth, in warm season. Oceanic, warm-water species.

Candacia longimana (CLAUS)

Very rare, at the mouth, in summer. Oceanic, warm-current species.

Candacia pachydactyla (DANA)

Very rare, in warm season, near the mouth. Oceanic, warm-water form.

Candacia pectinata BRADY

Very rare, near the mouth, in summer.

Candacia truncata (DANA)

Rare, at the mouth, in warm season. Warm-water form.

Candacia sp. 1

Candacia sp. 2

Family 17. Pontellidae

Calanopia elliptica (DANA)

Rare, near the mouth, in summer. Oceanic, warm-current species.

Calanopia thompsoni SCOTT

More or less common, widely distributed in inlet waters. Ubiquitous, warm-water form. (YAMAZI, 1959, p. 114)

Labidocera acuta (DANA)

Common, in open sea water, in summer and autumn. Oceanic, subtropical species.

Labidocera acutifrons (DANA)

Very rare, at the mouth, in summer and autumn. Oceanic, warm-current species.

Labidocera bipinnata TANAKA

Rare, found almost everywhere in the bay, especially outside. Widely distributed, warm-water species. (YAMAZI, 1959, p. 114)

Labidocera detruncata (DANA)

Very rare, near the mouth, in summer, subtropical and south-temperate species.

Labidocera japonica MORI

More or less common, inside and outside the bay, in summer.

Labidocera kröyeri (BRADY)

Rare, outside and inside the bay, in warm season. Warm-water form.

Labidocera pavo GIESBRECHT

Common inside and outside the bay, in summer season, chiefly oceanic, but frequently neritic, and littoral.

Labidocera sp. 1

Labidocera sp. 2

Labidocera sp. 3

Labidocera sp. 4

Labidocera sp. 5

Labidocera sp. 6

Labidocera sp. 7

Pontella chierchiae GIESBRECHT

Very rare, in open sea water near the mouth, in summer. Oceanic, warm-water species.

Pontella surrecta WILSON ?

Very rare, near the mouth, in summer.

Pontella sp.

Pontellina plumata (DANA)

Rare, in summer and autum. Oceanic, warm-water form.

Pontellopsis armata GIESBRECHT

Very rare, near the mouth, in summer. Oceanic, warm-water species.

Pontellopsis tenuicauda GIESBRECHT

Very rare, near the mouth, in summer. Warm-current species.

Pontellopsis yamadai MORI

Very rare, inside and outside the bay, in autumn and winter.

Pontellopsis sp. 1

Pontellopsis sp. 2

Family 18. Acartiidae

Acartia clausi GIESBRECHT

Most abundant inside the inlet, from winter to early summer. Euryhaline, neritic, and littoral, temperate species. (YAMAZI, 1959, p. 71, 111, 124)

Acartia danae GIESBRECHT

Temperate species, rare in the bay.

Acartia erythraea GIESBRECHT

Very common inside the inlet, in warm season, in early summer and autumn. Neritic and littoral, warm-water species. (YAMAZI, 1959, p. 111, 124)

Acartia hamata MORI

Common inside the inlet, in summer and autumn. Neritic and littoral, warm-water form.

Acartia negligens DANA

Rare in the bay, in summer and autumn. Neritic warm-water species.

Acartia pacifica STEUER

Common in the inlet, in warm seasons.

Acartia spinicauda GIESBRECHT

Rare, in littoral area of the bay, in summer and autumn. Neritic and littoral, warm-water form.

Family 19. Tortanidae

Tortanus forcipatus GIESBRECHT

Common, in coastal and inlet waters, in warm seasons. Warm-water form. (YAMAZI, 1959, p. 111, 115)

Suborder *CYCLOPOIDA (PODOPLEA)*

Family 20. Oithonidae

Oithona decipiens FARRAN

Rare, in open sea water outside the bay, in warm season. Oceanic, warm-water species.

Oithona farax FARRAN

Rare, oceanic, south-temperate, warm-water form.

Oithona nana GIESBRECHT

The most abundant copepod in the innermost part of the bay, in almost all seasons. Neritic or littoral, south-temperate, widespread form. (YAMAZI, 1959, p. 66, 124)

Oithona plumifera BAIRD

Common but not abundant in open sea water. Oceanic, south-temperate species. (YAMAZI, 1959, p. 184)

Oithona rigida GIESBRECHT

Sometimes abundant outer part of the bay in summer and autumn. Neritic warm-water form. (YAMAZI, 1959, p. 124, color pl. 2)

Oithona robusta GIESBRECHT

Very rare found occasionally in summer and autumn. Oceanic, warm-water form.

Oithona setigera DANA

Rare, found in open sea water out of the bay. Oceanic, warm-water form.

Oithona similis CLAUS

Common in tow-netting in the outer part of the bay, in colder season. Neritic and oceanic, north-temperate but widely distributed form. (YAMAZI, 1959, p. 125)

Family 21. Macrosetellidae

Macrosetella gracilis (DANA)

Rare, in the open sea water outside the bay, in summer and autumn. Oceanic, tropical or subtropical species. (YAMAZI, 1959, p. 32, 67)

Miracia efferata DANA

Only one species in the bay, in summer. Female in dark greenish blue.

Family 22. Ectinosomidae

Microsetella norvegica (BOECK)

Common, in winter and spring, outside the bay. Neritic, wide spread, occasionally oceanic, temperate species.

Microsetella rosea (DANA)

Fairly common, in warm season, outer part of the bay. Neritic, warm-water form. (YAMAZI, 1959, p. 125)

Family 23. Tachdiidae

Euterpe acutifrons (DANA)

Common, in the outer part of the bay, all the year round, neritic, sporadically oceanic, warm-water form.

Family 24. Clytemnestridae

Clytemnestra rostrata (BRADY)

Very rare, found occasionally in warm season, outside the bay. Oceanic, subtropical and south-temperate warm-water species.

Clytemnestra scutellata DANA

Very rare, oceanic subtropical warm-water species.

Family 25. Oncaeidae

Lubbockia marukawai MORI

Rare, in open sea water outside the bay, in summer. Warm-water form.

Lubbockia squillimana CLAUS

Rare, in open sea water outside the bay, in summer. Warm-water form.

Oncaea media GIESBRECHT

Abundant, sometimes in swarms, commonest in summer. Neritic and oceanic, subtropical and south-temperate, widespread form.

Oncaea venusta PHILIPPI

Most abundant in the outer part of the bay. Oceanic but frequently neritic, north-temperate species. (YAMAZI, 1959, color pl. 2)

Oncaea sp. 1

Oncaea sp. 2

Family 26. Corycaeidae

Copilia mirabilis DANA

Rare, in open sea not far from the Laboratory, chiefly in summer and autumn. Oceanic, tropical species. (YAMAZI, 1959, p. 57, 66, color pl. 2)

Copilia quadrata DANA

Very rare, outside, open sea water, in summer and autumn. Oceanic, tropical and subtropical form. (YAMAZI, 1959, p. 57)

Corycaeus affinis MURRICH (=*Corycaeus japonicus* MORI; *Corycaeus anglicus*)

Very common, inside and outside the inlet, in winter and spring season. Neritic, north temperate species.

Corycaeus asiaticus F. DAHL

Very rare, oceanic warm-water species.

Corycaeus catus F. DAHL

Rare, outside open water, in summer and autumn.

Corycaeus concinnus DANA

Very rare, outside, in summer. Oceanic, warm-water form.

Corycaeus crassiusculus DANA

Common, inside and outside the bay, in warm season. Oceanic form.

Corycaeus flaccus GIESBRECHT

More or less common, in summer and autumn. Oceanic, tropical species. (YAMAZI, 1959, color pl. 2)

Corycaeus gibbulus GIESBRECHT

Rare, inside and outside the bay, in summer and autumn. Oceanic, warm-water form.

Corycaeus lautus DANA

Common, inside and outside the bay, in summer season. Oceanic, warm southern form.

Corycaeus longistylis DANA

Common, outside the bay, in summer. Oceanic, southern species.

Corycaeus speciosus DANA

Very rare, outside the inlet, in summer and autumn. Oceanic, tropical and subtropical species.

Corycaeus sp. 1

Corycaeus sp. 2

Corycaeus sp. 3

Corycaeus sp. 4

Corycaeus sp. 5

Corycaeus sp. 6

Pachysoma dentatum MORI

Very rare, open sea, in summer season. Oceanic, warm-water southern form.

Sapphirina angusta DANA

Very rare, in open sea water, in summer. Oceanic, warm-water species.

Sapphirina gastrica GIESBRECHT

Very rare, outside the inlet, in summer. Oceanic, warm-water species.

Sapphirina gemma DANA

Rare, in open sea water, in summer and autumn. Oceanic, warm-water species.

Sapphirina intestinata GIESBRECHT

Very rare, in open sea water, in summer. Oceanic, tropical and subtropical warm-current form.

Sapphirina nigromaculata CLAUS

Very rare, in open sea water, in summer. Oceanic, warm-current form. (YAMAZI, 1959, p. 122)

Sapphirina opalina DANA

Rare, in open sea water, in summer and autumn. Oceanic, tropical and subtropical warm-current species. (YAMAZI, 195, color pl. 2)

Sapphirina stellata GIESBRECHT

More or less common, in open sea water, in summer. Oceanic, tropical and subtropical warm-current species. (YAMAZI, 1959, p. 35, 122)

Suborder *MONSTRILLOIDA*

Family 27. Monstrillidae

Haemocera morii TOKIOKA

Very rare, in summer, in the bay. (TOKIOKA, 1949)

Monstrilla sp. 1

Very rare, in the bay, in warm season. (YAMAZI, 1959, p. 114)

Monstrilla sp. 2

Monstrilla sp. 3

Monstrilla sp. 4

Monstrilla sp. 5

Monstrilla sp. 6

Suborder *HARPACTICOIDA*

Family 28. Harpacticidae

Tigriopus japonicus MORI

Very abundant in rock pools above high water mark, throughout the year, especially from spring to autumn. (YAMAZI, 1959, p. 104, 144)

Harpacticus sp. 1

Harpacticus sp. 2

Harpacticus sp. 3

Harpacticus sp. 4

Family 29. Idyidae

Idya sp. 1

Idya sp. 2

Idya sp. 3

Idya sp. 4

Subclass *MALACOSTRACA*

Order LEPTOSTRACA

Nebalia bipes FABRICIUS

Very rare. Tichopelagic, saprofagous form.

Order CUMACEA

Bodotria sp.

Tichopelagic form, coming up to the surface at night. (YAMAZI, 1959, p. 143)

Diastylis sp.

Tichopelagic form, coming up to the surface at night. (YAMAZI, 1959, p. 143)

Paradiastylis sp.

Order MYSIDACEA

Proneomysis misakiensis II

Common, all the year round, usually near the bottom in daytime and comes up to the surface at night.

Siriella watasei NAKAZAWA

Very common, in almost all seasons, widely distributed in the bay. Neritic, and littoral form, comes up to the surface at night. (YAMAZI, 1959, p. 116)

Order AMPHIPODA

Suborder *HYPERIIDEA*

Family 1. Vibiliidae

Vibilia gibbosa BOVALLIUS

Very rare, found in open water near the mouth, in summer. Oceanic, warm-water form.

Family 2. Paraphronimidae

Phronima colletti BOVALLIUS

Very rarely found in open water near the mouth, in summer. Oceanic, warm-water form.

Phronima sedentaria (FORSKÅL)

Very rarely found in open water near the mouth, in summer. Oceanic, warm-water form. (YAMAZI, 1959, p. 109, 179)

Phronimella elongata CLAUS

Very rarely, found in open sea water near the mouth, in summer. Oceanic, warm-water form. (YAMAZI, 1959, p. 179)

Family 3. Hyperiidae

Hyperia galba (MONTAGU)

Very rare, found chiefly in open sea water near the mouth, in summer.

Hyperia latissima BOVALLIUS

Fairly common, almost all seasons, inside and outside the bay.

Hyperia schizogeneios STEBBING

Very rare, found in open sea water.

Hyperia sp. 1

Hyperia sp. 2

Hyperia sp. 3

Hyperia sp. 4

Hyperia sp. 5

Hyperia sp. 6

Hyperia sp. 7

Hyperia sp. 8

Hyperia sp. 9

Hyperia sp. 10

Hyperioides longipes CHEVREUX

Very rare, in open sea water outside the bay, in summer and autumn. Oceanic, warm-water form.

Parascelus tyhoides CLAUS

Very rare, in open water outside the inlet, in summer. Oceanic, warm-water form.

Phronimopsis spinifera CLAUS

Very rare, in open sea water near the mouth, in summer. (YAMAZI, 1959, p, 180)

Themisto gracilipes NORMAN

Very rare, in open sea water outside the inlet, in summer. Oceanic, warm-current form.

Family 4. Anchylomeridae (Phrosinidae)

Anchylomera Blossevillei MILNE EDWARDS

Very rare, near the mouth of the bay, in summer and autumn. Oceanic, warm-water form.

Euprimno macropus (CRERIN)

Very rare, in open sea water near the mouth, in summer and autumn. Oceanic. Warm-water form.

Phrosina semilunata RISSO

Rare, found occasionally met with near the mouth of the bay, in summer. Warm-water species. (YAMAZI, 1959, p. 109)

Family 5. Platyscelidae

Platyscelus serratulus STEBBING

Very rare, found occasionally near the mouth, in summer. Oceanic, warm-water species.

Platyscelus sp.

Tetrathyrus forcipatus CLAUS

Very rare, found only near the mouth of the bay, in summer. Warm-water species.

Family 6. Scelidae

Eupronoe minuta CLAUS

Rare, found only near the mouth, in summer and autumn.

Parascelus typhoides CLAUS

Rare, found occasionally in summer, near the mouth. Warm-water species.

Family 7. Lycaeidae

Brachyscelus crusculus BATE

Very rare, outside and near the mouth of the bay, in warm season. Warm-water, oceanic species.

Brachyscelus latipes STEBBING

Very rare, near the mouth of the bay, in summer. Warm-water species. (YAMAZI, 1959, p. 109)

Family 8. Oxycephalidae

Glosocephalus sp. 1

Very rare, near the mouth of the bay, in summer. (YAMAZI, 1959, p. 180)

Glosocephalus sp. 2

Very rare, near the mouth of the bay, in summer. (YAMAZI, 1959, p. 180)

Oxycephalus porcellus CLAUS

Very rare, found only near the mouth of the bay, in warm seasons. Oceanic, warm-water form. (YAMAZI, 1959, p. 180)

Oxycephalus sp.

Rhabdosoma sp.

Very rare, near the mouth of the bay, in summer. (YAMAZI, 1959, p. 180)

Order EUPHAUSIACEA

Euphausia sp.

Oceanic, warm-water form.

Order DECAPODA

Lucifer typus MILNE EDWARDS [=*L. raynaudii* BATE]

Very common, inside and outside the bay, in summer and autumn. Widely distributed, warm-water species. (YAMAZI, 1959, p. 32, 118, 121)

Phylum **PROCHORDATA**

Class UROCHORDA (TUNICATA)

Subclass *APPENDICULARIA* (*COPELATA*)

Appendicularia sicula FOL

Rare in the bay, in warm seasons. Oceanic, warm-water form.

Fritillaria charybdae LOHMANN

Very rare, in open sea water.

Fritillaria fraudax LOHMANN

Very rare, occasionally found in open sea water.

Fritillaria haplostoma FOL

Commonest in the bay, in summer and autumn, at times in swarms. Oceanic, warm-water form. (YAMAZI, 1959, p. 198)

Fritillaria formica FOL

Fairly common in the bay. Oceanic, south-temperate form.

Fritillaria megachile FOL

Very rare. Oceanic, warm-water form.

Fritillaria pellucida (BUSCH)

Commonest in the bay, in warm seasons. Oceanic, warm-water form.

Fritillaria tenella LOHMANN

Common, inside and outside the bay. Oceanic, warm-water form. (YAMAZI, 1959, p. 198)

Fritillaria venusta LOHMANN

Very rare, in open sea water near the mouth of the bay. Oceanic, warm-water form. (YAMAZI, 1959, p. 198)

Megacercus huxleyi (RITTER)

Rare, found almost anywhere, especially outside the bay in early summer. Oceanic, warm-water form. (YAMAZI, 1959, p. 200)

Oikopleura cophocerca GEGENBAUR

Rare, in open sea water near the mouth of the bay. Oceanic, warm-water form. (YAMAZI, 1959, p. 47, 105, 200)

Oikopleura dioica FOL

Very common in the bay throughout the year, especially in warm seasons. Inlet water form. (YAMAZI, 1959, p. 127)

Oikopleura fusiformis FOL

Common, in open sea water near the mouth of the bay, frequently inside, in late spring and summer. Oceanic, warm water form. (YAMAZI, 1959, p. 200)

Oikopleura gracilis LOHMANN

Rare, in open sea water near the mouth of the bay, from early summer to autumn. Oceanic form.

Oikopleura intermedia LOHMANN [=*O. macrostoma* AIDA]

Very rare, found occasionally in open sea water near the mouth of the bay. Oceanic, warm-water form.

Oikopleura longicauda (VOGT)

Commonest, especially in late spring and summer. Oceanic, warm-water form. (YAMAZI, 1959, p. 200)

Oikopleura parva LOHMANN

Rare, in open sea water near the mouth of the bay. Oceanic form.

Oikopleura rufescens FOL

Common, in open sea water near the mouth of the bay, in summer and autumn. Oceanic, warm-water form. (YAMAZI, 1959, p. 200)

Stegosoma magnum (LANGERHANS)

Common, in open sea water near the mouth of the bay. (YAMAZI, 1959, p. 200)

Subclass *THALIACEA*

Order DOLIOLIDA (CYCLOMYARIA)

Doliolum denticulatum QUOY et GAIMARD

Moderately frequent in the bay, in summer and autumn. Abundant at times in swarms. Oceanic, warm-water form. (YAMAZI, 1959, p. 59, 101, 194) Found almost throughout the year. (TOKIOKA, 1937, p. 219)

Doliolum gegenbauri ULJANIN [=*D. tritonis* HERDMAN]

Rare, in open sea water near the month of the bay, in spring and summer, sometimes in swarms. Oceanic, warm-water form. (YAMAZI, 1959, p. 104, 194)

Doliolum nationalis BORGERT

Very common outside the bay, sometimes in swarms, in spring and summer. (YAMAZI, 1959, p. 194)

Order SALPIDA (HEMIMYARIA)

Cyclosalpa affinis (CHAMISSO)

Abundant at times in swarms in summer. Oceanic, warm-water species. Found in water (TOKIOKA, 1937, p. 221)

Cyclosalpa komaii IHLE et IHLE-LANDENBERG [=*C. virgula* KOMAI]

Very rare, in open sea water, in winter and spring. (KOMAI, 1932, TOKIOKA, 1937, p. 221)

Cyclosalpa pinnata (FORSKÅL)

Very rare, in warm seasons. Oceanic, warm-water form.

Cyclosalpa pinnata var. **polae** (SIGL.)

Rare, in spring and summer, in the outer part of the bay. Oceanic, warm-water form. (YAMAZI, 1959, p. 195) Found in autumn and winter. (TOKIOKA, 1937 p. 220)

Iasis zonaria (PALLAS)

Rare, occasionally found in the outer part of the bay. (YAMAZI, 1959, p. 195) In autumn and winter. (TOKIOKA. 1937, p. 224)

Ihlea asymmetrica (FOWLER)

Rare, in open sea water, in spring and early summer. Oceanic, warm-water form. (YAMAZI, 1959, p. 195) Found in spring. (TOKIOKA. 1937, p. 222)

Pegea confoederata (FORSKÅL)

Common but not abundant, in winter and early summer, very abundant in February. (YAMAZI, 1959, p. 104, 196)

Ritteriella picteti (APSTEIN)

Very rare, from early spring to summer, in open sea water near the mouth of the bay. Oceanic, warm-water form. Found in winter. (TOKIOKA, 1937, p. 222)

Salpa cylindrica CUVIER

Common, in open sea water, especially in early spring and summer. (YAMAZI, 1959, p. 59, 197) Found in spring. (TOKIOKA. 1937, p. 230)

Salpa fusiformis CUVIER

Fairly common in open sea water outside the bay, in almost all seasons, especially in spring and early summer. Oceanic, warm-water form. Found in winter. (TOKIOKA, 1937 p. 223)

Thalia democratica (FORSKÅL) var. **echinata** TOKIOKA

Rare. Oceanic, warm-water form. Found in winter. (TOKIOKA, 1937, p. 229)

Thalia democrarica (FORSKÅL) var. **orientalis** TOKIOKA

Very common in almost all seasons, especially in spring and early summer. Oceanic, warm-water form. (YAMAZI, 1959, p. 196) Found almost throughout the year. (TOKIOKA, 1937, p. 226–229)

Thetys vagina (TILESIUS)

Rare in the outer part of the bay, in spring and early summer. Oceanic, warm-water form. (YAMAZI, 1959, p. 197) Found in winter and spring. (TOKIOKA, 1937, p. 226)

Order PYROSOMATA

Pyrosoma atlanticum atlanticum PÉRON

Rare, in open sea water outside the bay, in spring and summer, very rarely drifted ashore. Oceanic, warm-water form. (YAMAZI, 1959, p. 119)

Pyrosoma sp.

Very rare, drifted ashore in fornt of the Laboratory, in warm season. (YAMAZI, 1959, p. 195)

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SECONDARY SEXUAL CHARACTERS IN JAPANESE SEA-URCHINS[1]

YUTAKA TAHARA
Morphological Laboratory, Osaka Liberal Arts University

MINORU OKADA
Sakuranomiya Junior High School, Osaka City

and

NAOMASA KOBAYASHI
Zoological Institute, Kyoto University

With Plates VII–VIII and 5 Text-figures

Introduction

The sexual dimorphism in various forms of echinoids has hitherto been reported by many authors, as was excellently reviewed by E. B. HARVEY (1956).

Independently from these discoveries of previous authors, TAHARA found the sexual difference of the genital papillae in *Mespilia globulus*, during his course of practical exercises of marine zoology for students in August, 1958, at the Seto Marine Biological Laboratory. Then, this observation was extended to other Japanese species of the sea urchin collected in the sea near the Laboratory, in cooperation with M. OKADA and N. KOBAYASHI. TAHARA studied the secondary sexual characters in *Mespilia globulus*, *Toxopneustes pileolus* and *Tripneustes gratilla*; OKADA in *Echinostrephus aciculatus* and *Diadema setosum*; and KOBAYASHI in *Echinometera mathaei*.

The authors are deeply indebted to Dr. Huzio UTINOMI and Dr. Takasi TOKIOKA of the Seto Marine Biological Laboratory and wish to express their hearty thanks to them for offering us convenience and various helpful suggestions and also for referring them to literatures. We wish to express deep gratitude to Dr. O. NAKAMURA of the Osaka Liberal Arts University for reading the manuscript of this paper. Thanks are also due to Messrs. T. YAMAMOTO, S. URA and S. SAKAI of that Laboratory, and to Mr. R. OKUNO of the Suma Aquarium, for their assistance in collecting materials.

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Observations

The present observations were made on the following six species of the sea urchin:

Mespilia globulus (LINNÉ)
Toxopneustes pileolus (LAMARCK)
Tripneustes gratilla (LINNÉ)
Echinometra mathaei (BLAINVILLE)
Echinostrephus aciculatus A. AGASSIZ
Diadema setosum (LESKE)

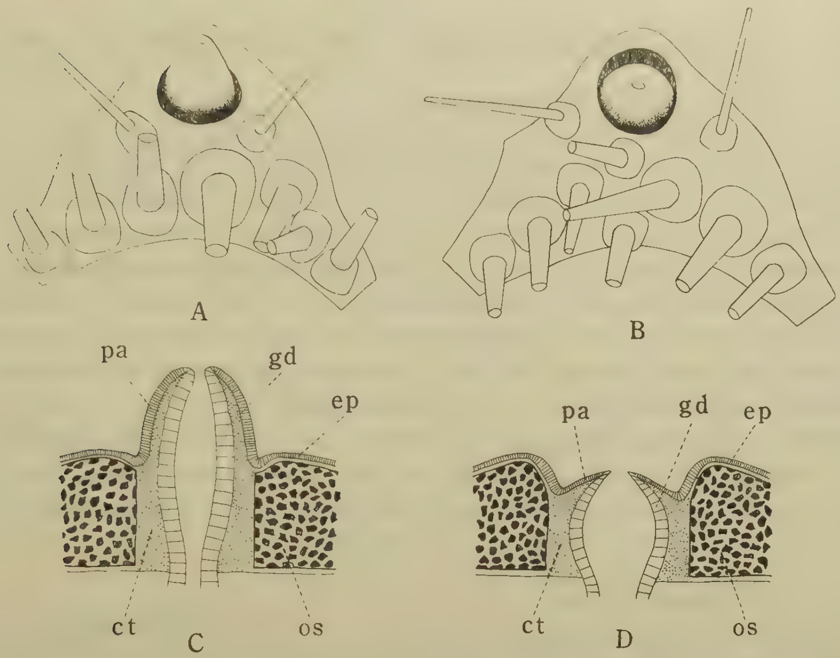
Freshly collected materials were observed under the binocular microscope with about ten magnifications and separated into two groups according to the shape of the genital papillae. Then the determination of the sex of each individual was made by the sexual elements taken at random from its gonads. From these results, it became clear that the genitial papilla in these species indicates a remarkable sexual dimorphism. Secondly, we investigated whether there exist other sexual characters or not. Though the characters examined varied with the species, the following were chosen in most cases: colour of spines, of tube feet, and of peristomeal membranes, the height of the tests (height-diameter ratios) and the size of the genital pores (diameter of the pores). The results obtained are presented here separately in each species.

1. *Mespilia globulus* (LINNÉ).

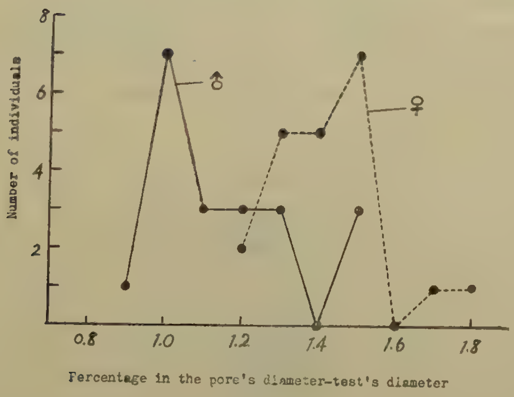
In this species, the male genital papilla protrudes on the body surface, forming a short cone. It rises to a height of about 110 micra. At the pointed end of the papilla, which is white in colour, there is an opening of the genital duct. Excepting this opening, the genital papilla is mostly colourless and semitransparent, but in some cases it bears minute dots, coloured dark olive green or reddish brown. On the other hand, the female genital papilla is flat and sunk below the body surface. Therefore, a clear, circular groove can be observed within the margin of the genital pore (Text-fig. 1 A and B; Pl. VII, figs. 1 and 2). There is no difference in colour between the genital papillae of both sexes.

The difference in the shape of the genital papilla mentioned above was confirmed by the microscopic observations of the sagittal sections. As is shown in Text-fig. 1, C and D, the male genital papilla is taller than that of the female. Besides, in the male, the epidermis becomes thicker and cells of which it is composed are compact at the genital papilla; while in the female there is no thickening of the epidermis at the papilla. The wall of the male genital duct is also thicker than that of the female.

In addition to these differences between sexes, we saw individual variations in the following external characters: the colour of the spine, the interambulacral area, tube feet, the peristomeal membranes and the aboral disks; the height of the tests and the size of the genital pores. The last of these shows a clear sexual difference. For the measurement of the diameter, the genital pore of the first genital plate was arbitrarily chosen, but when it was abnormal — for example, when the first genital



Text-fig. 1. *Mespilia globulus.* A. The fourth genital plate showing male genital papilla. B. The fifth genital plate showing female genital papilla. C and D. Diagrammatic sagittal sections of genital papillae of male (C) and of female (D). *ct.*···connective tissue. *ep.*···epidermis. *gd.*···wall of genital duct. *os.*···ossicle of genital plate. *pa.*···wall of genital papilla.



Text-fig. 2. Frequency curves for both sexes. The mean values of diameter of pores to diameter of tests are 1.2 per cent in the male and 1.4 per cent in the female respectively.

plate had two or more pores — the pore in another plate was chosen for measurement. Text-figure 2 shows the results. As can be seen in the graph, the size of the female genital pore is generally larger than that of the male. The other characters show no sexual differences.

Since the sexual difference of the genital papillae is very clear, we can distinguish the two sexes of the living animals with ease and accuracy. It is best to put the materials in sea-water and make observation under the binocular microscope of about ten magnifications, but with the help of the magnifying glass, we can distinguish the sexes with accuracy in the air. We used more than 100 individuals for observation during this summer, and were deceived in seven cases.

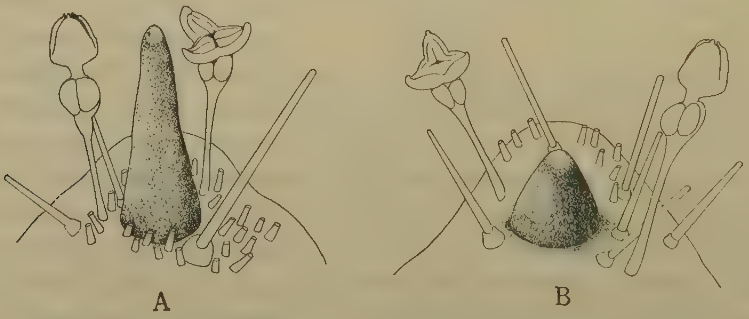
2. *Toxopneustes pileolus* (LAMARCK).

The genital papilla of the male is a short, stumpy, conical protuberance; while the female papilla is, in most cases, flat and sunk below the body surface, their shapes closely resembling those of *Mespilia* (Pl. VII, figs. 3 and 4). But, among the females, there are a few individuals of which the genital papilla considerably protrudes on the body surface. In the female, however, the circular groove at the base of the papilla being deeper than the male, it is not impossible to distinguish such females from males. We were deceived in four cases out of twenty-four (15%). The genital papilla of both sexes is colourless and semitransparent, but in some cases it bears minute red or white dots near the base of the papilla.

Other external characters, such as the colour of spines, of valves of the globiferous pedicellariae and of peristomeal membranes, the height of the tests and the size of the genital pores were examined, and we could not detect any sexual differences in them.

3. *Tripneustes gratilla* (LINNÉ).

In this species, the male genital papilla is very long and measures about 3 mm in length in large individuals. It is almost equal to the length of the large globiferous pedicellariae surrounding the papilla and longer than the small spinules standing at the base of the papilla. It is penis-like in shape tapering off to the end. Excepting its pointed end, at which the genital duct opens, the papilla has the same colour as the skin, that is, it has minute purplish brown or orange coloured dots. On the other hand, the female genital papilla is stumpy, conical protuberance with obtuse end. It measures about 1.5 mm in length in large individuals. And it is shorter than both the stalk of the large globiferous pedicellariae and small spinules at the base of the papilla (Text-fig. 3 and Pl. VII, figs. 5 and 6). Its colour does not differ from the male papilla. Thus the genital papilla of this species is so large that one can distinguish the both sexes with the naked eye by finding out and observing the papilla on



Text-fig. 3. *Tripneustes gratilla.* A. Genital papilla of male. B. Genital papilla of female.

the madreporic plate. We examined fifty-seven individuals in all and were deceived only one case.

Moreover, the following external characters were examined: colour of the spines, tube feet, the peristomeal membrane; the height of the tests and size of the genital pores. All of these have no clear sexual differences.

4. *Echinometra mathaei* (BLAINVILLE).

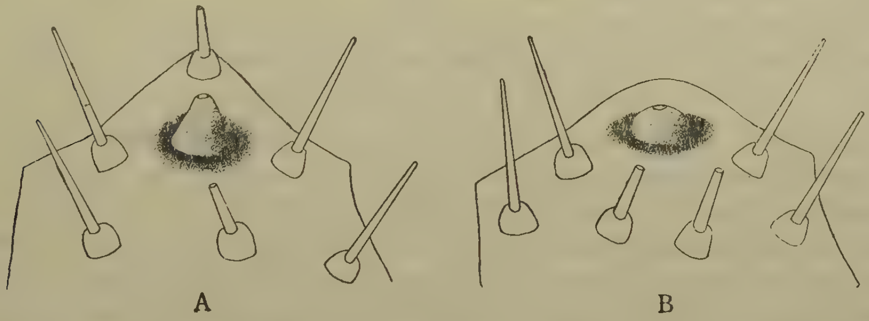
In the male, the genital papilla is long, slender and a penis-like projection with a pointed end. It measures about 1 mm in length in the longest one. As is shown in the photomicrographs (Pl. VIII, figs. 7 and 8), the length of the male genital papilla is in most cases more than half of that of the small spinules which are found near by the papilla. While in the female, the protuberance of the genital papilla is shorter than in the male. It is stumpy and has an obtuse end. As the photomicrograph shows, its length is always less than half of that of the neighbouring spinules. Its colour is dark purplish red in both sexes, except the white genital opening.

We also examined the colour of spines, of tube feet, of peristomeal membranes, the height of the tests and the size of the genital pores. But we could not find no clear sexual differences.

We comitted several errors — six cases out of forty-four (14%) — in this species. They were caused due to the fact that the length of the male genital papillae was often less than half of that of the spinules standing near by the papillae.

5. *Echinostrephus aciculatus* A. AGASSIZ.

The male genital papilla protrudes conically. And it has a pointed end. On the contrary, the female genital papilla is a short, obtuse-headed and wart-like protuberance (Text-fig. 4).

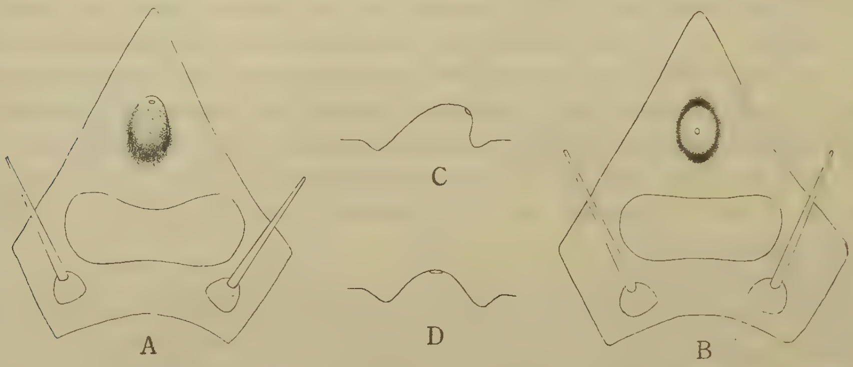


Text-fig. 4. *Echinostrephus aciculatus*. A. Genital papilla of male. B. Genital papilla of female.

Besides, the following individual variations were examined: the shape of the genital plates, the height of the tests and the size of the genital pores. Of these, the size of the genital pores shows a clear sexual difference. We examined eight cases in the male and fourteen in the female and obtained results that the mean values of diameter of pores to diameter of tests 1.2 per cent in the male and 1.4 per cent in the female respectively.

6. *Diadema setosum* (LESKE).

In the male, the genital papilla is longer than that in the female and protrudes on the body surface, inclining at about forty-five degrees towards proximo-distal direction of the genital plate. In the female the genital papilla is only a short, wart-like projection with an obtuse end (Text-fig. 5, A–D; Pl. VIII, figs. 9 and 10). Its colour is very dark purple excepting the tip of the papilla both in the male and the female.



Text-fig. 5. *Diadema setosum*. A. The first genital plate showing male genital papilla. B. The first genital plate showing female genital papilla. C and D. Profiles of genital papillae of male (C) and of female (D).

Besides these, the colour of the interambulacral area, oral tube feet, the height of the tests and the size of the genital pores were examined. None of these shows clear sexual difference.

We recorded twenty-two cases in all in this species with no errors. If one observes the genital papilla on individuals with light coloured interambulacral areas, the determination of the sexes can easily be performed with the naked eye.

Besides these six species hitherto described, the shape of the genital papillae in *Clypeaster japonicus* was examined. In this species the genital papilla forms a considerably long tube with a pointed end. And we could not find any constant morphological differences between both sexes. Moreover, the studies are now in progress concerning the secondary sexual characters in other two species of the sea urchin: *Hemicentrotus pulcherrimus* and *Anthocidaris crassispina* and the results of which shall be reported at an early opportunity.

Conclusions

The sexual differences of the genital papillae in six species of the sea urchin described above may be roughly classified into the following two types:

a) *Mespilia* type. The genital papillae of the male are short, conical protuberances, while those of the female are flat and sunk below the body surface. *Mespilia globulus* and *Toxopneustes pileolus* belong to this type.

b) *Tripneustes* type. The genital papillae of the male form remarkably long tubes, whereas those of the female are short and stumpy protuberances. *Tripneustes gratilla, Echinometra mathaei, Echinostrephus aciculatus* and *Diadema setosum* belong to this type.

In Europe, the sexual differences of the shape of the genital papillae have been found in several species of the sea urchin, and used for the purpose of separating two sexes in living animals. It is HAMANN (1887) who first discovered the sexual dimorphism in the genital papilla. He described that the female papilla in *Echinocardium mediterraneum* is thicker and shorter than the male. After that, MARX (1929) also found that in *Psammechinus miliaris* and *Echinocyamus pussilus* the shape and colour of the genital papillae are conspicuously different between both sexes. According to this author, in *Ps. miliaris* the male has short and stumpy genital papillae with terminal swellings, while the female has no papillae, its genital pores being covered with membranes of a light bluish colour. And in *E. pussilus* the genital papilla of the male is very long and penis-like, while in the female it is short and conical. It may be said, therefore, that he found two types of the sexual differences in genital papillae, namely, *Ps. miliaris* belonging to the *Mespilia* type and *E. pussilus* to the *Tripneustes* type. Recently, SWANN (1954) observed the shape of the genital papillae in the following six European species of the sea urchin: *Psammechinus miliaris, Ps. microtuberculatus, Echinus esculentus, Paracentrotus lividus, Sphaerechinus granularis* and *Arbacia lixula.* He found that in all these species except *Arbacia lixula* the genital papillae show clear sexual differences. The genital pores of the male are borne on short papillae which show glistening white at its edge, while in the female the genital apertures are not borne on papillae but are more or less sunk below the level of the surroundings, and has no whitish colour. Accordingly, all these species may be grouped into the *Mespilia* type.

We have confirmed the findings of these authors in the Japanese species of the sea-urchin. Moreover, we have found by microscopic observations that the genital openings of the female in *Mespilia globulus* are borne on the flat *papillae,* and not on the *membranes* as was stated by MARX in European species of the sea urchin belonging to the *Mespilia* type (Text-fig. 1, C and D).

We have also found that in *Mespilia globulus* and *Echinostrephus aciculatus* the size of the genital pore of the female is generally larger than that of the male (Text-fig. 2). This secondary sexual character has also been reported by MORTENSEN (1928–51), IKEDA (1931) and TYLER (1944). In his exhaustive works, MORTENSEN describes the sexual dimorphism of the genital pores in many species of echinoids, belonging to the genera *Prionechinus, Caenopedina* and *Echinocyamus* as well as to the families Cidariidae, Scutellidae and Neolampadidae. According to him, in these species the male genital pores are smaller as compared with the female and are more distally situated on the genital plates. IKEDA also reports that in *Temnopleurus toreumaticus* the male genital pore is in most cases rather smaller than the female and is situated almost at the center of the genital plate, while the female pore is shifted a little towards the periphery. TYLER also describes that in *Lytechinus anamesus* and *L. pictus* the genital pore of the female is larger than that of the male.

Besides these, there are many reports concerning the sexual differences in the height of the tests, colour of the bodies or of the tube feet on the oral side. We examined these characters in each of our species, but so far we have found no clear sexual differences by which we can distinguish sexes of living animals with certainty.

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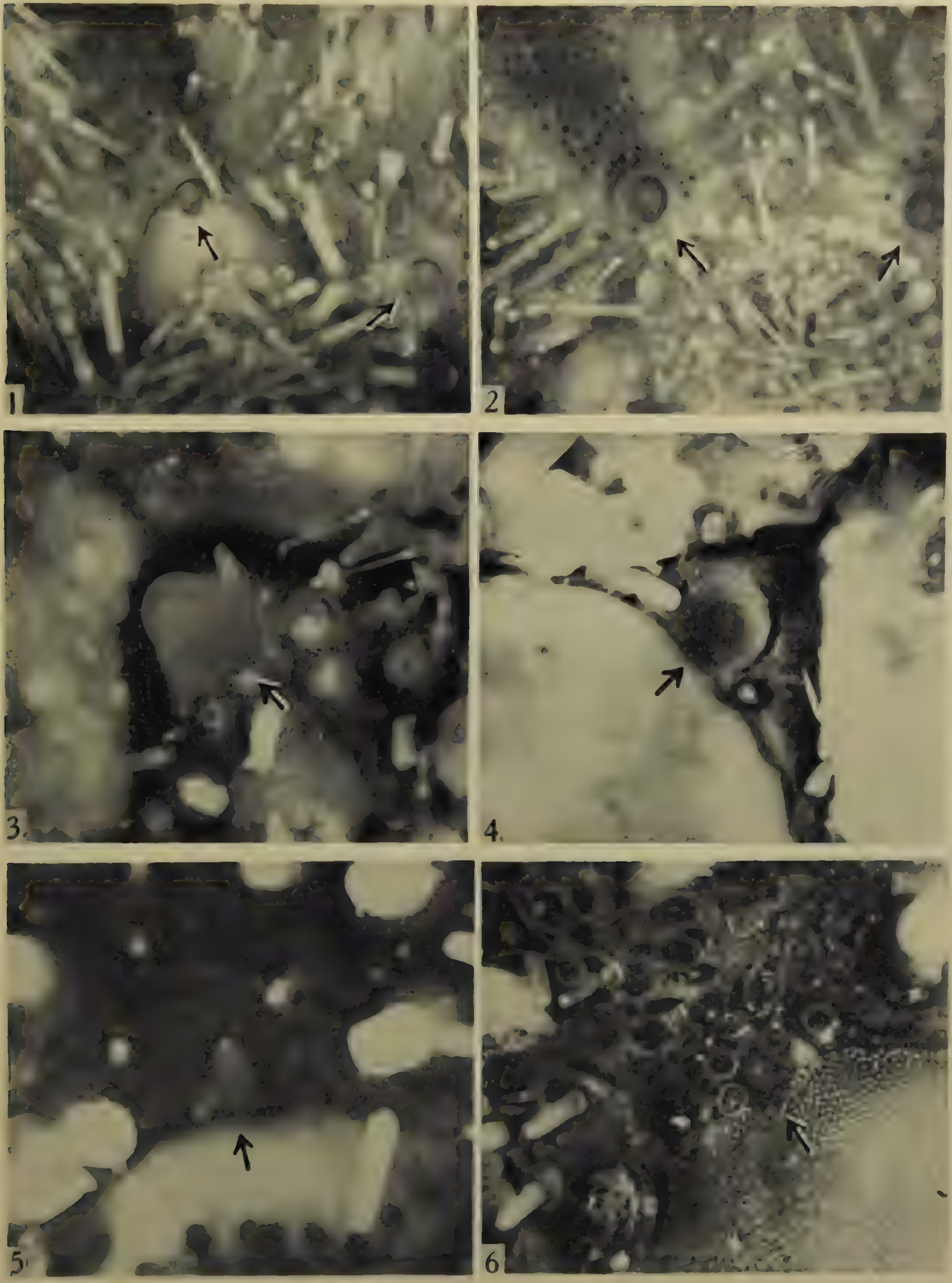
EXPLANATION OF PLATES VII–VIII

PLATE VII

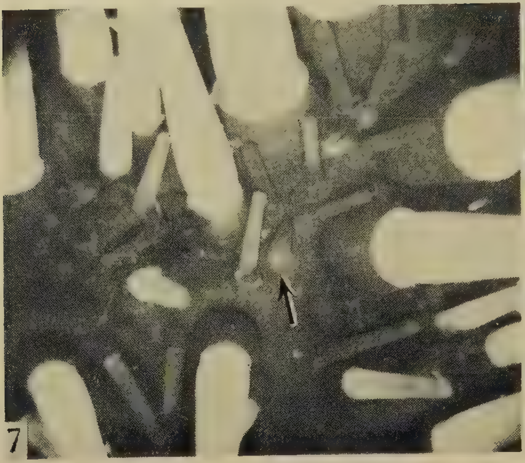
Fig. 1. *Mespilia globulus*; Male. Magnification about 17×.
Fig. 2. *M. globulus*; Female. Magnification about 17×.
Fig. 3. *Toxopneustes pileolus*; Male. Magnification about 17×.
Fig. 4. *T. pileolus*; Female. Magnification about 17×.
Fig. 5. *Tripneustes gratilla*; Male. Magnification about 7×.
Fig. 6. *T. gratilla*; Female. Magnification about 7×.

PLATE VIII

Fig. 7. *Echinometra mathaei*; Male. Magnification about 14×.
Fig. 8. *E. mathaei*; Female. Magnification about 14×.
Fig. 9. *Diadema setosum*; Male. Magnification about 9×.
Fig. 10. *Diadema setosum*; Female. Magnification about 9×.



Y. TAHARA ET AL.: SECONDARY SEXUAL CHARACTERS IN JAPANESE SEA-URCHINS.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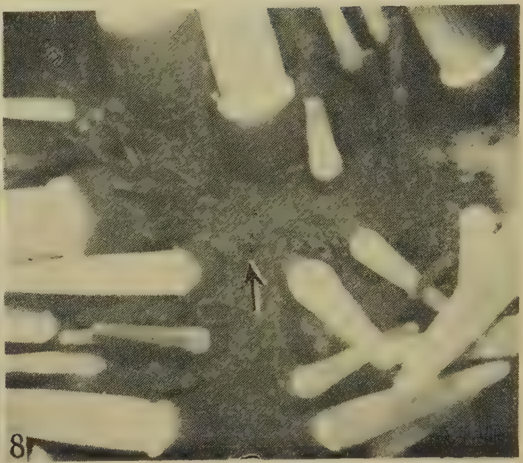
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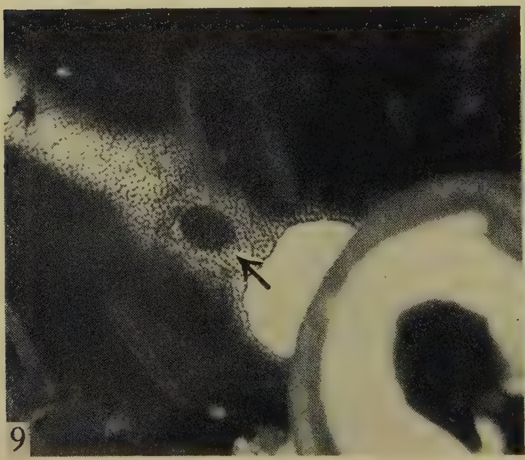
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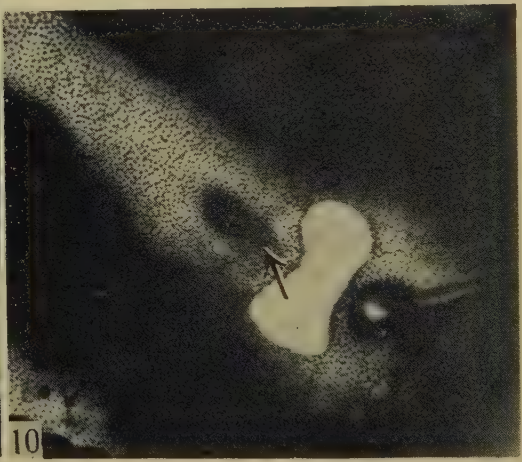
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Y. TAHARA ET AL.: SECONDARY SEXUAL CHARACTERS IN JAPANESE SEA-URCHINS.

NOTES ON THE NAUPLIOSOMA AND NEWLY HATCHED PHYLLOSOMA OF *IBACUS CILIATUS* (VON SIEBOLD)[1]

Eiji HARADA

Seto Marine Biological Laboratory, Sirahama

With Plates IX–XI and 2 Text-figures

Introduction

The purpose of the present paper is to afford some contributions to the post-larval development of a common scyllarid lobster *Ibacus ciliatus* (von Siebold), together with some knowledge on the biology of its larvae.

For our knowledge of the phyllosoma larvae of *Ibacus ciliatus*, we have the reports of many investigators, such as de Haan (1833–1850), Richters (1873), Balss (1914), Stephensen (1923), Gurney (1936), Tokioka (1954), etc., but if these reports are consulted, it may clearly be shown that the phyllosomas which were treated and described in these reports are all of the later developmental stages, and no case in the earlier stages of the phyllosoma is available. This may be mainly due to that the phyllosomas in these reports are those largely obtained in the field by chance or during the courses of large-scaled oceanographical investigations. This may also be met with in the case if we take the phyllosomas of other species into account. For instance, if one intends to make comparison of the newly hatched phyllosomas of certain species, one will be sure to find a number of species of which the newly hatched phyllosoma is undescribed. Our present knowledge of the phyllosomas is so fragmental from the point of view of their life histories, that we are hardly able to trace a sequence of all stages of the phyllosomas of a definite species, and to compare them with any corresponding stages in other species. Much uncertainty is thus left to make it impossible to identify the phyllosomas of the field collection, even if these phyllosomas are possibly in the newly hatched stage.

Since the summer of 1956, I have made some efforts to hatch out and breed up the phyllosomas of various Palinurids and Scyllarids in the laboratory, that are inhabiting in the vicinity of the Seto Marine Biological Laboratory. I have got some newly hatched phyllosomas of several species, but in no case I succeeded to metamor-

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[1] Contributions from the Seto Marine Biological Laboratory, No. 321.

Publ. Seto Mar. Biol. Lab., VII (1), 1958. (Article 7)

phose them into their second stages. It is my intention to describe these newly hatched phyllosomas to enable to identify the phyllosomas of the field collections, contributing to obtain a better knowledge of their life histories, and here I deal with *Ibacus ciliatus* at the first step.

I would like to take this opportunity of extending my sincerest thanks to Dr. Huzio UTINOMI, Dr. Denzaburo MIYADI and Dr. Takasi TOKIOKA for many suggestions and valuable advice during the course of this study.

Meterials and Methods

Ibacus ciliatus commonly occurs on the sandy or muddy bottom, in somewhat deeper area along the coast of Kii Peninsula, and is captured by the trawl net.

On April 16th, 1958, I obtained two berried females from the commercial landings of the trawl-net fishery at Kii-Tonda, some seven kilometres south-east of the Laboratory, and kept them in an aquarium ($0.5 \times 0.5 \times 0.4\,m^3$). The eggs of one of these two females were in an advanced stage. The eggs were almost spherical and their diameters were ranging from 0.95 mm to 1.05 mm. The embryos in advanced eggs had already absorbed most of their yolk and the eggs were whitish or almost transparent in appearance. Appendages of the embryos were well developed, closely folded around their bodies. The black pigmentation of their eyes was complete and very conspicuous. Their hearts were beating. The eggs of this female only could succeed to hatch out after four days rearing.

The hatching out occurred at the midday of April 20th. The female lifted her abdomen and shook it for several times, making the larvae escape from the eggs. She repeated this action for several times at the interval of about ten minutes, resulting the hatching out of the whole eggs. These larvae were not the phyllosomas but in the form of the naupliosoma as described by GILCHRIST (1913). They could swim about swiftly with the aid of their setose branched second antennae, some of them went upward to the surface and some of them stayed near the bottom. But this form was not held for a long time, and, within thirty minutes, these naupliosoma larvae moulted and took the form of the ordinary phyllosoma. The phyllosomas had no swimming second antennae, but they moved around with the aid of exopods of the thoracic appendages, as in cases of other species. It was a very remarkable fact that these newly hatched phyllosomas were never attracted to the light, but they went away from the light to the darker corner of the aquarium, showing negative phototaxis. These phyllosomas were kept and reared in the aquarium, from which the adult animals were removed after they hatched out, being feeded with the boiled egg-yellow. They ate it, but after five days rearing more than a half of them died, and all after fifteen days rearing, resulting no moult.

The naupliosoma and the newly hatched phyllosoma within several days after the hatching out are described below.

The First Stage Phyllosoma

The newly hatched phyllosoma, just after the moult from the naupliosoma to this form, had somewhat shriveled body and was whitish in colour, but later became swelled and highly transparent. It measured at first 1.9–2.3 mm in the body length and 1.5–1.9 mm in the fore-body width, but after a week 2.6–2.9 mm and 2.1–2.4 mm respectively.

The *fore-body* (cephalic shield) is almost quadrate in outline, but slightly concave at the posterior end, and broader than the hind-body, its width being about 1.5 times its length. The *hind-body* (thorax) is not concave behind. The *abdomen* is not segmented and without trace of pleopods, ending in two pointed processes armed with three setae on each side.

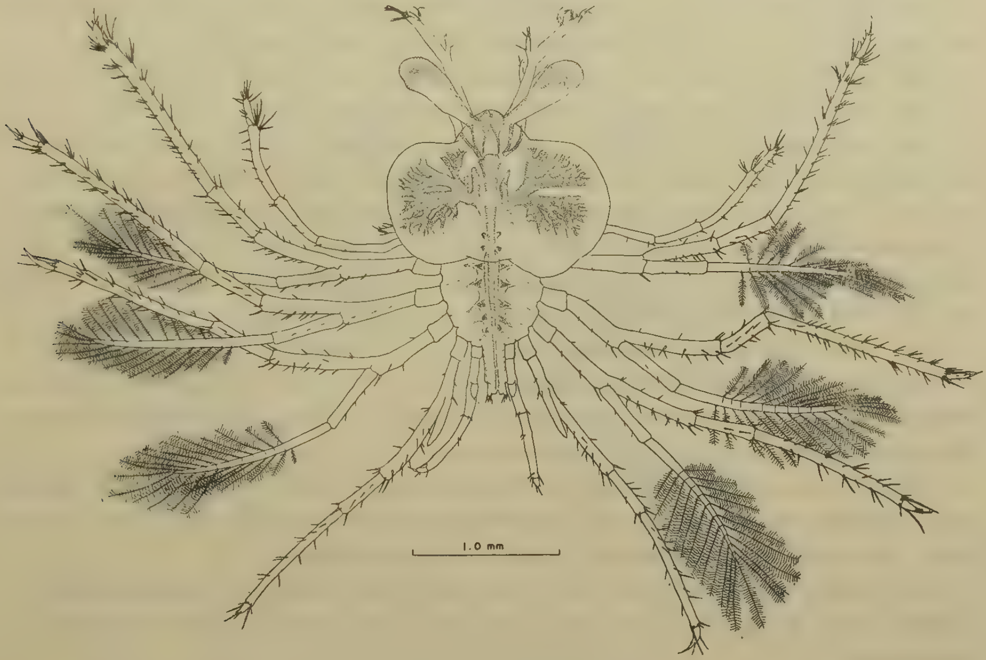

Fig. 1. The dorsal view of the newly hatched phyllosoma of *Ibacus ciliatus.*

The *eyes* are not stalked.

The *first antenna* (antennule) is long and has a short branch, not cut off at the base, on its inner-dorsal surface at the middle. The distal end of the first antenna bears a tuft of three long and a short setae. There are also other two tufts of long setae near the tip, composed of three and two setae respectively. The branch has two points at the tip and a very small seta near the base. The first antenna has no segmentation at all.

The *second antenna* (antenna) is about half of the first antenna in length and also has a branch on the inner-dorsal side at the middle. The distal end of the second antenna is armed with two spinous processes. The branch, not cut off at the base, bears three setae at the tip and a very small seta near the tip. The second antenna is also unsegmented.

The *mandible* is very stout and ends in a complicatedly toothed blade edge.

The *first maxilla* has two branches, each of them being armed with spines and setae.

The *second maxilla* has two segments, the distal one being small and bearing four long setose setae.

The *first maxilliped* is a very small simple stump.

The *second maxilliped* is composed of five segments, without an exopod and not reaching the distal end of the second segment of the third maxilliped.

The *third maxilliped* is of five segments, without an exopod, and bears no stout claw-like spine at the distal end. Distal two segments are armed with setae.

The *first*, *second* and *third legs*, five-segmented, have well developed exopod on the dorsal side of the second segment of each. These legs are almost equal in length and 1.6–1.7 times as long as the body length. Last four segments have many setae. A large claw-like spine presents at the tip. The fourth segment is longer than others. The exopod is composed of two segments, about a half length of the leg, of which the distal one bears eleven to twelve pairs of long setose setae.

The *fourth leg*, with five segments and about 3/4 length of the second leg, bears a rudimental, though somewhat elongated, exopod on the second segment, which is unsegmented and not definitely cut off at its base. Last four segments have setae, with a large spine at the end of the last segment.

The *fifth leg*, with four segments and a very rudimentary budlike exopod on the second segment not completely cut off, is about equal in length to the second maxilliped. Few setae present, but with a large spine at the tip.

The *coxal spines* are present on the legs from the first to the fourth, bearing an accessary seta on its base. On the maxillipeds, there is only a seta instead of the coxal spine.

The newly hatched phyllosoma of *Ibacus ciliatus* thus differs much from that of other species hitherto described. It is larger in size than that of *Panulirus*, *Palinurus*, *Scyllarides*, or *Scyllarus*, as described by NAKAZAWA (1917), JOHNSON (1956), CUNNINGHAM (1892), LEBOUR (1950), etc. and also observed by myself. Moreover, we found distinct characteristics which have not been described yet in any reports, that is: (1) The first and second antennae are both biramous; (2) there exist five legs with an exopod; (3) numbers of the pair of the setose seta on the second segments of the exopods of the first to third legs are eleven to twelve, that are larger than that of *Panulirus*, *Scyllarides* and *Scyllarus*, but similar to that of *Palinurus*; (4) the fore-body is exceedingly broad; (5) legs are relatively shorter than in others.

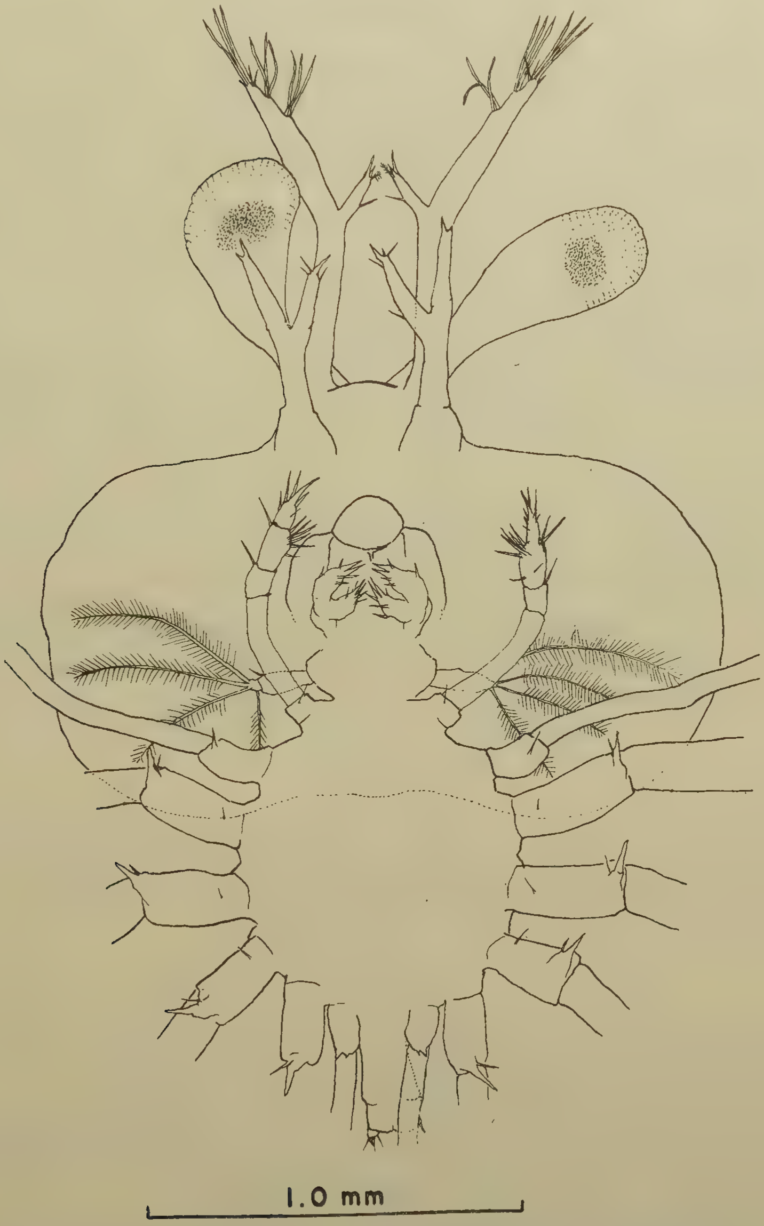

Fig. 2. The ventral view of the newly hatched phyllosoma of *Ibacus ciliatus.*

Although the definite conclusion must be awaited until other members of these genera of lobsters, including *Ibacus* itself, are examined more closely, these characteristics, especially the first two, might be considered as generic.

The Naupliosoma

The naupliosoma of *Ibacus ciliatus* seems to be a free-swimming larva, but this stage is passed through in a very short time. As will be reported in the succeeding papers, the larvae of the form of the naupliosoma hatched out when the eggs in the advanced stage of *Scyllarides squamosus* (H. MILNE EDWARDS) were artificially shaken in the laboratory. Such naupliosoma-formed larvae of *Scyllarides squamosus* have setose, seven-branched, second antennae, but they are not able to swim at all. On the contrary, the naupliosoma of *Ibacus ciliatus* has strong power of swimming with the aid of second antennae.

The naupliosoma is enclosed in a thin membrane, through which the phyllosoma to be moulted is visible. So, there is no great difference in the basic plan of its structure between the naupliosoma and the newly hatched phyllosoma, except that there is no setae at all on appendages in the former and except for the form of the first and second antennae.

The *first antenna* of the naupliosoma is not biramous and has no setae as in the newly hatched phyllosoma described above, though the biramous first antenna of the following stage is discernible in it.

The *second antenna* terminates into eight setose branches, and is longer than that of the following stage, which is discernible in the first (proximal) and last (distalmost) branches.

Field Collection

The field collection has been made in shallow waters in front of the Seto Marine Biological Laboratory since the spring of 1955, but no phyllosoma nor naupliosoma of the form described above was found in the towing samples, although many other phyllosomas were captured, mainly of *Panulirus japonicus*.

Summary

1. The naupliosoma and first stage phyllosoma of *Ibacus ciliatus* (VON SIEBOLD) were described, that were hatched out and reared in the laboratory.

2. It was suggested that the presence of the biramous first and second antennae and five legs from the first time when the larvae took the form of the phyllosoma might be took as the most conspicuous generic characters.

3. Some notes on the behaviour of the naupliosoma and newly hatched phyllosoma in an aquarium condition were presented.

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EXPLANATION OF PLATES IX-XI

PLATE IX

The newly hatched phyllosoma of *Ibacus ciliatus*.

Fig. A. Left first and second antennae, dorsal view.
Fig. B. Mouth parts, ventral view.
Fig. C. Right second maxilla, ventral view.
Fig. D. Right second maxilla and first maxilliped, ventral view.
Fig. E. Blade edge of left mandible and left lower lip, ventral view.
Fig. F. Blade edge of right mandible, dorsal view.
Fig. G. Left first maxilla, ventral view.
Fig. H. Right second maxilliped, ventral view.
Fig. I. Right third maxilliped, ventral view.
Fig. J. Left fifth leg, dorsal view.

PLATE X

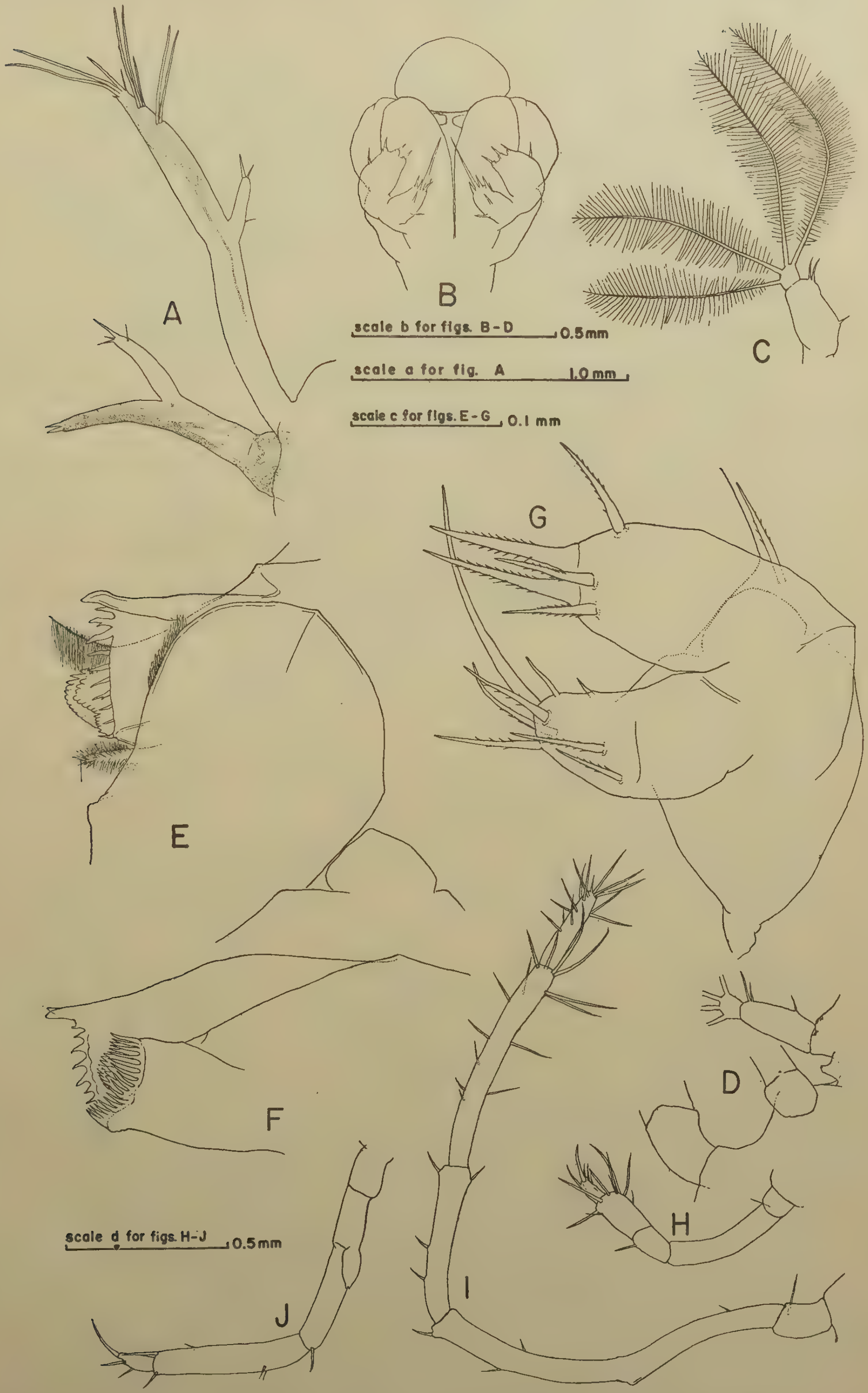
The newly hatched phyllosoma of *Ibacus ciliatus*.

Fig. K. Second segment of exopod of left second leg, dorsal view.
Fig. L. Distal portion of left second leg. dorsal view.
Fig. M. Left fourth leg, dorsal view.
Fig. N. Coxal spines of left second to fourth leg, ventral view.
Fig. O. Abdomen, dorsal view.

PLATE XI

The naupliosoma of *Ibacus ciliatus*.

Fig. P. Right first antenna, dorsal view.
Fig. Q. Left second antenna, dorsal view.
Fig. R. Right second maxilla and second maxilliped, ventral view.
Fig. S. Left third maxilliped and first leg, dorsal view.
Fig. T. Abdomen and right fourth and fifth legs, dorsal view.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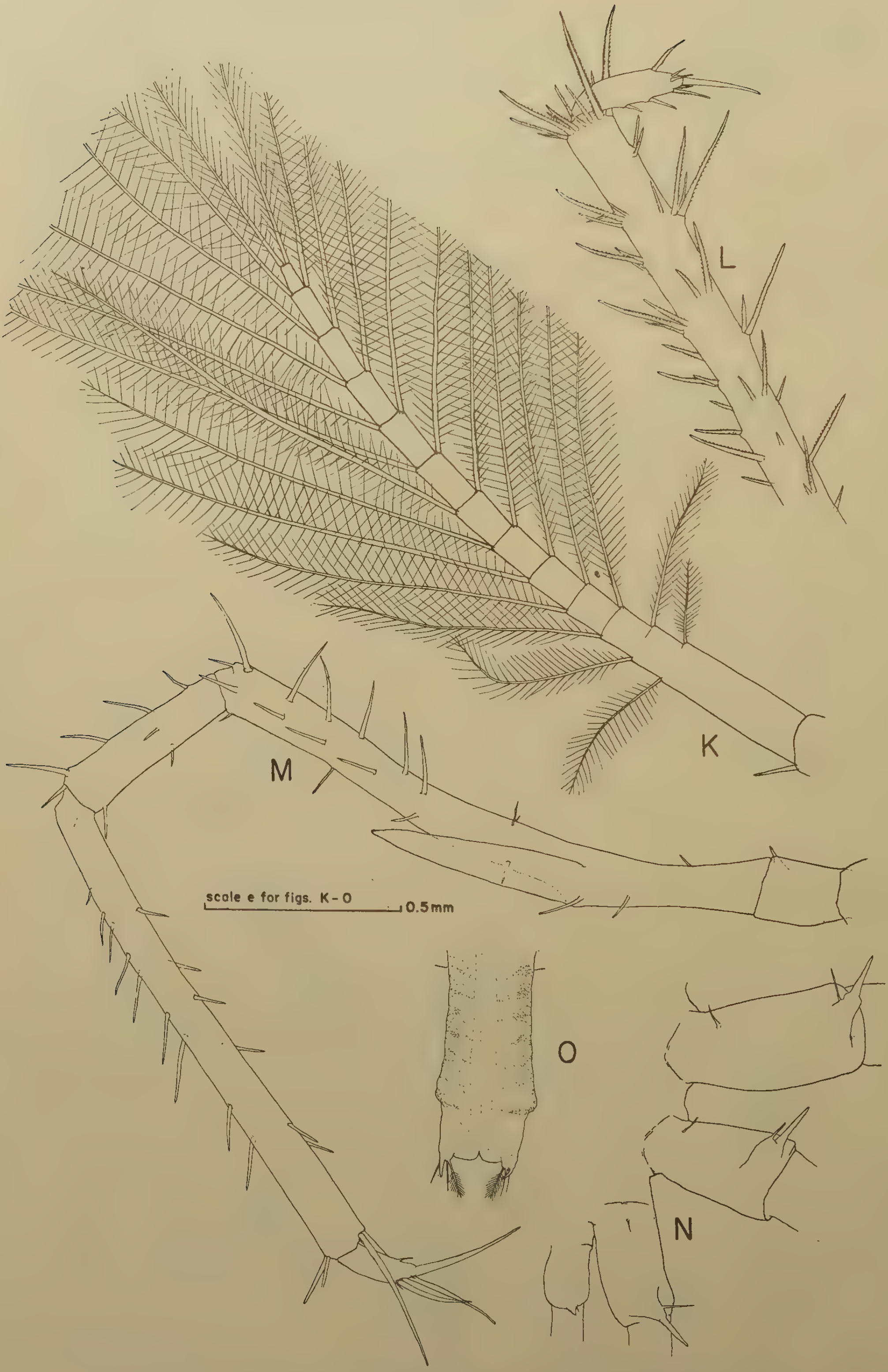
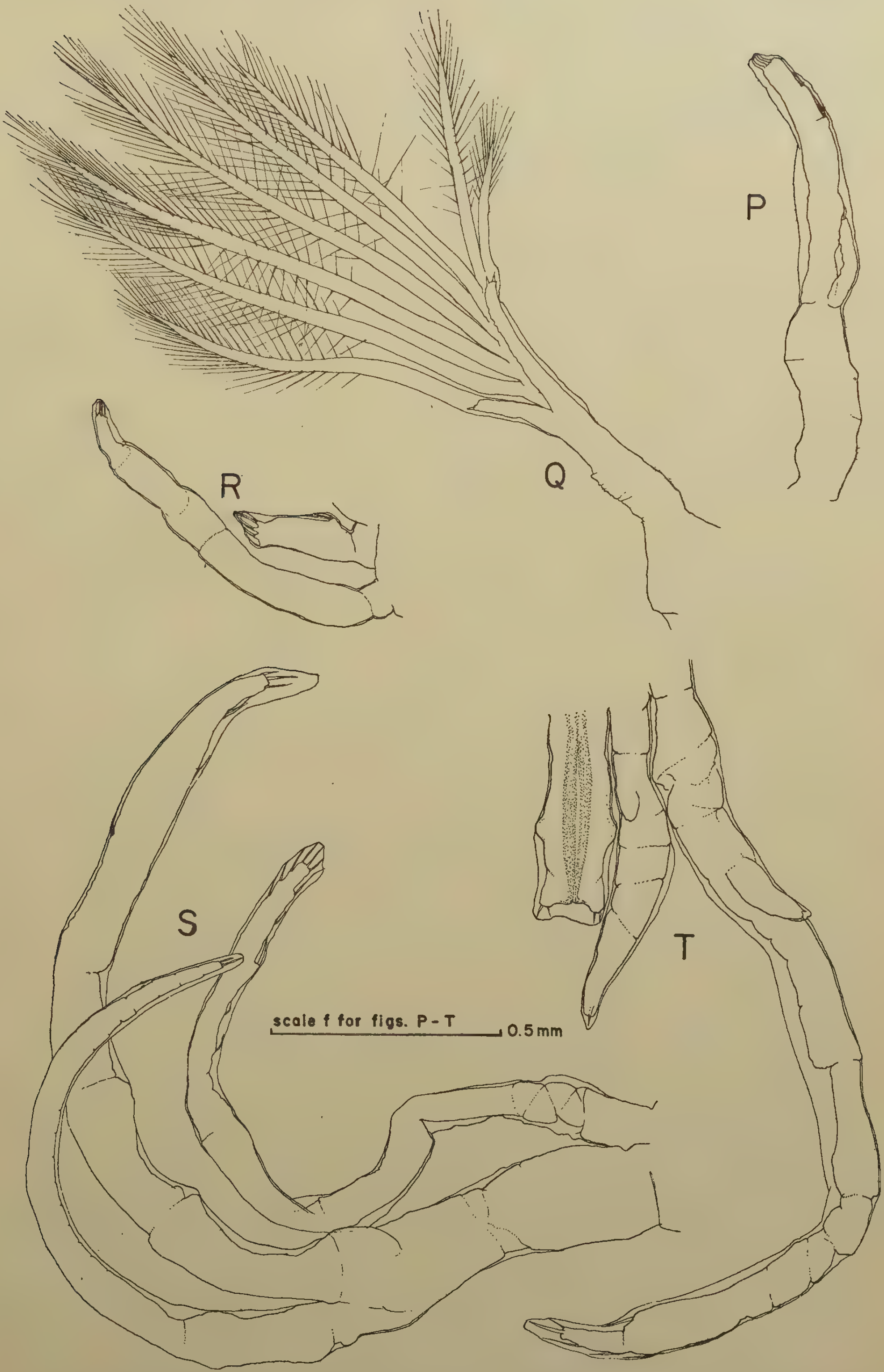
E. HARADA: NAUPLIOSOMA AND PHYLLOSOMA OF *IBACUS CILIATUS*.



E. HARADA: NAUPLIOSOMA AND PHYLLOSOMA OF *IBACUS CILIATUS*.



E. Harada: Naupliosoma and Phyllosoma of *Ibacus ciliatus*.

STUDIES ON THE PIGMENTS OF MARINE ANIMALS

VI. CAROTENOIDS OF SOME TUNICATES[1]

KOKICHI NISHIBORI

Notre Dame Seishin College, Okayama

With Plate XII, 3 Tables and 6 Text-figures

Numerous, solitary and compound, tunicates show various colourations (red, orange, pink, etc.) owing to the presence of carotenoids. The distribution of carotenoids in tunicates has been studied by many investigators, and a comprehensive study was made by GOODWIN (1952), as summarized in Table 1.

Table 1. Carotenoid distribution in tunicates (after GOODWIN, 1952).

Species	α-Carotene	β-Carotene	Echinenone	Lutein	Capsanthin	Capsorubin	Cynthiaxanthin	Astaxanthin	Pectenoxanthin
Botryllus schlosseri				+	+	+			+
Ciona intestinalis				+					
Clavellina lepadiformis		+		+					
Corella parallelogramma		?		+					
Halocynthia papillosa	+	+					+	+	
Dendrodoa grossularia	+	+						+	
Microcosmus sulcatus	?		?						
Molgula occulta		?		?					
Myxilla mammillaris		?		?					
Styela rustica		+		?					

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[1] Contributions from the Seto Marine Biological Laboratory, No. 322.

Publ. Seto Mar. Biol. Lab., VII (1), 1958. (Article 8)

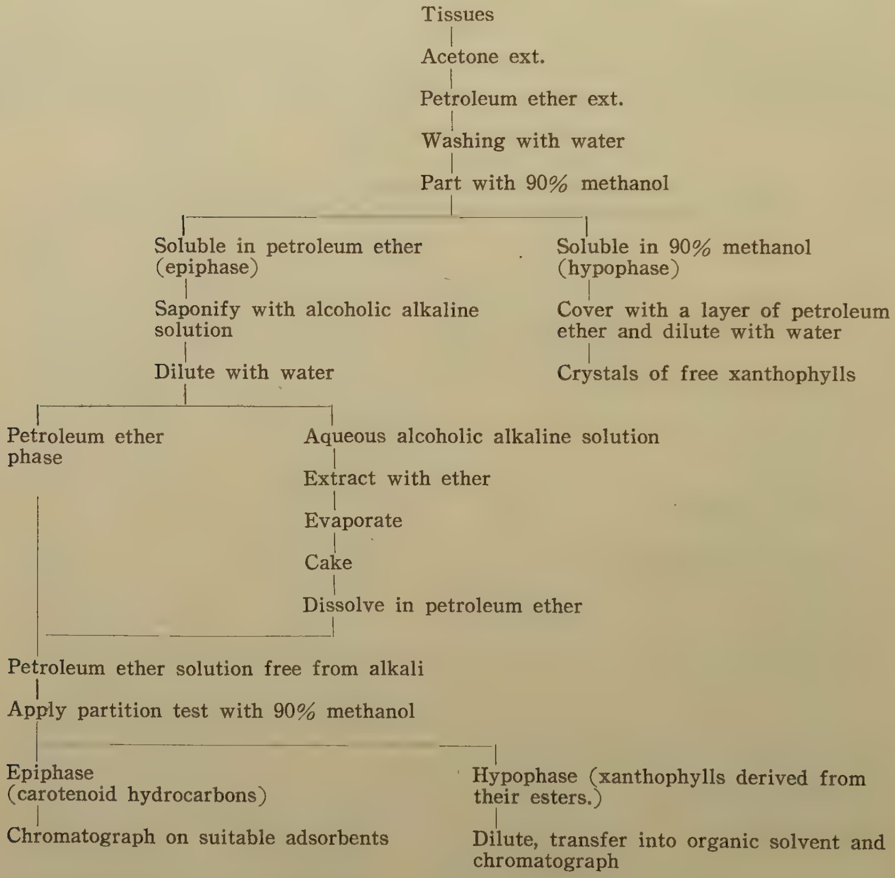
I have made some comparative studies of the carotenoids in four kinds of tunicates, three of which belong to the solitary form, *Halocynthia roretzi* (VON DRASCHE) (I)[1], *Pyura michaelseni* (OKA) (II) and *Styela plicata* (LESUEUR) (III) and one of the compound form, *Amaroucium pliciferum* (REDIKORZEV) (IV).

The materials used for the experiment were collected at Hakodate, Hokkaido (I), Shirahama, Wakayama Prefecture (II, III) and Ushimado, Okayama Prefecture (II, IV).

Experimental

The general extraction and isolation method used in this report is shown in Table 2. Details in each species of the tunicates are described below:

Table 2. Extraction and isolation method for tunic carotenoids.


Tissues
Acetone ext.
Petroleum ether ext.
Washing with water
Part with 90% methanol
Soluble in petroleum ether (epiphase)
Saponify with alcoholic alkaline solution
Dilute with water
Soluble in 90% methanol (hypophase)
Cover with a layer of petroleum ether and dilute with water
Crystals of free xanthophylls
Petroleum ether phase
Aqueous alcoholic alkaline solution
Extract with ether
Evaporate
Cake
Dissolve in petroleum ether
Petroleum ether solution free from alkali
Apply partition test with 90% methanol
Epiphase (carotenoid hydrocarbons)
Chromatograph on suitable adsorbents
Hypophase (xanthophylls derived from their esters.)
Dilute, transfer into organic solvent and chromatograph

I. *Halocynthia roretzi* (Japanese name, Maboya)

An amount of 1350 gram of fresh tunics from 66 living specimens, collected at

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[1] The experimental studies on the sample (I) were carried out at Hokkaido University.

Hakodate, Hokkaido, was used for the acetone extraction.

When the petroleum ether solution (bright deep red) containing the red pigments was washed with water in order to remove the acetone, crystalline orange-red materials were deposited on the surface boundary. The crystalline materials (A) were separated from the acetone-free petroleum ether solution (deep red) (B). The yield of (A) was about 560 mg.

Isolation of cynthiaxanthin: After washing with petroleum ether and recrystallization from the hot ethanol-water, the crystals (A) (m. p. 185～6°C) were then chromatographed on calcium carbonate; an amount of 30 mg of the crystals in 20 c.c. of ethereal solution was put into the column of calcium carbonate (2.8 cm × 25 cm) and developed with ether.

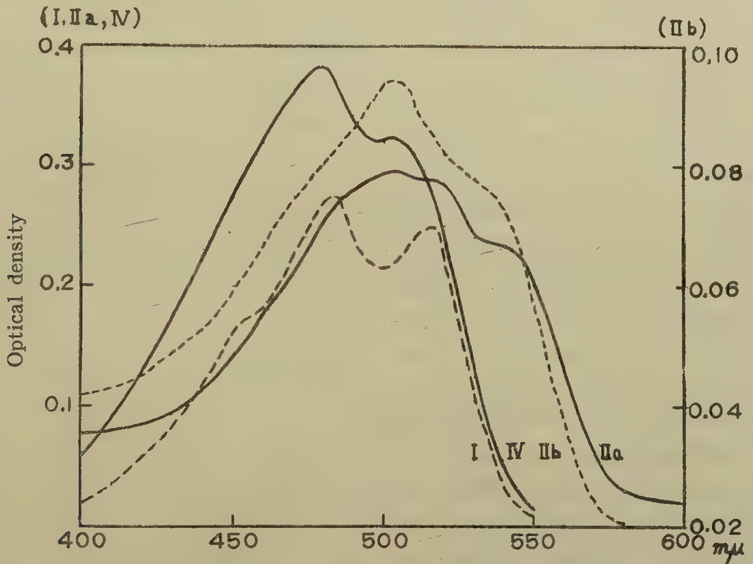

Fig. 1. Absorption spectra of cynthiaxanthin (I) from *Halocynthia roretzi*, a carotenoid (II a) and (II b) from the old (II a) and new (II b) specimens of *Pyura michaelseni* and a carotenoid (IV) from *Amaroucium pliciferum*, in carbon disulphide.

Two zones, the upper, brown red thin zone, and the lower, yellow orange main zone, were formed. The upper zone remained, when the main zone moved down through the column by the development with ether. An amount of 22 mg of the refined crystals, m. p. 190～2°, was recovered after recrystallization. (Plate XII, fig. 1).

Absorption spectrum and some other properties were summarized in Fig. 1, I and Table 3.

This pigment was soluble in methanol, ethanol, acetone, pyridine, ether, chloroform and benzene, but only slightly in petroleum ether. Blue colour was effected with CARR-PRICE reagent and with conc. H_2SO_4, but no colouration was given with conc. HCl.

Table 3. The principal carotenoids in the tunics of four tunicates.

Species	*Halocynthia roretzi*		*Pyura michaelseni*	*Styela plicata*	*Amaroucium pliciferum*
Colour of tunic	dark red		reddish or pale-brownish purple; siphons deep red	light dark red	red
Carotenoid	Cynthia-xanthin	Astacene	A xanthophyll	A xanthophyll	A xanthophyll
Crystalline form	orange long prism	black-violet sickle shaped needle	black-violet sickle shaped needle		orange needle
Melting point (°C)	190~2	223~5	194~6		166
Absorp. max. ($m\mu$)	451, 483, 517. CS_2		500~506, ~540. CS_2		479, 503. CS_2
	420~5, 450, 480. P.E.	~500. pyridine	488~494, ~514. pyridine	(~410), ~435, 460, ~490. $CHCl_3$	
Partition test	hypophasic	hypophasic	hypophasic	hypophasic	hypophasic

These properties indicate that this pigment is undoubtedly identical with cynthiaxanthin.

Isolation of astacene: Fraction (B) was divided into epiphase and hypophase by shaking it with 90% methanol. Most of the red pigment in (B) was changed into the hypophase (deep red colour), while the epiphase gave only orange yellow. When the methanol solution containing hypophasic pigments was covered with a layer of petroleum ether and diluted with water, then the violet red crystals were deposited at the boundary of the two layers. The yield was about 130 mg. The crystals were washed with petroleum ether, then dissolved in a small amount of boiling ethanol and the insoluble violet-black crystals were separated from the mother solution containing some more cynthiaxanthin. The crystals were washed with petroleum ether and methanol repeatedly and crystallized from pyridine-water. The melting point was 204°C and the yield was 26 mg. Then the crystals were dissolved in ethanolic potassium hydroxide, diluted with a small amount of water, and acidified with 50% acetic acid after the addition of a layer of petroleum ether. After that, the black violet crystals precipitated at the boundary of two layers, and these were recrystallized from pyridine-water as sickle-shaped needles (m. p. 223~5°C) after washing with hot water and petroleum ether.

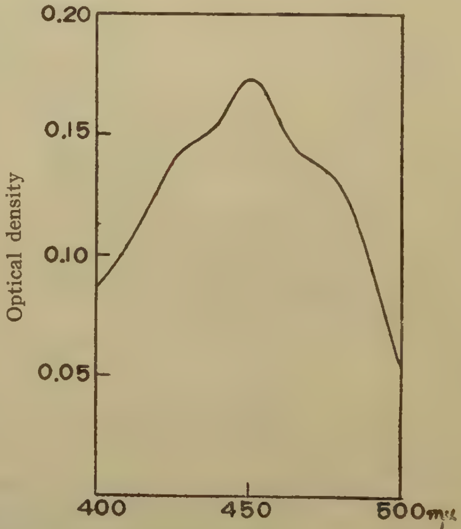

Fig. 2. Absorption spectrum of whole epiphasic carotenoid in *Halocynthia roretzi*, in petroleum ether.

The absorption maximum showed at about 500 mμ in pyridine. It was soluble in chloroform and pyridine but sparingly in petroleum ether and methanol. CARR–PRICE reaction (+) violet-blue, conc. H_2SO_4 reaction (+) blue. The melting point of the crystal did not fall when the mixed examination was carried on with astacene (m. p. 227∼8°C, absorp. max. 500 mμ in pyridine, isolated from a crustacean (*Pandalus* sp.).

Thus, this pigment is identical with astacene. It seems that the astacene was recovered from the free astaxanthin in the tunic.

Carotenoids in epiphase: The carotenoid contents of this fraction (carotenoid hydrocarbons and xanthophyll esters) were so poor that the crystalline pigments could not be isolated. The absorption maxima of whole epiphase showed at ∼430, 450, ∼480 mμ in petroleum ether (light orange yellow in colour) (Fig. 2).

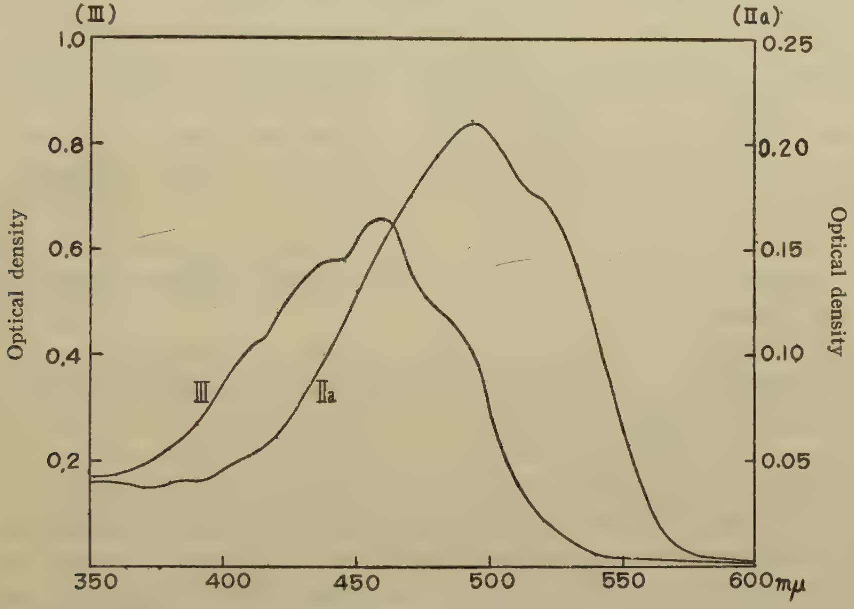

Fig. 3. Absorption spectra of a carotenoid from *P. michaelseni* (II a) and a carotenoid from *S. plicata* (III) in chloroform.

II. *Pyura michaelseni* (Japanese name, Mihaeruboya)

The pigments of this tunicate were examined on specimens collected at two different localities, one from Shirahama in Wakayama Pref. (specimens II a), and the other from Ushimado in the Seto Inland Sea (specimens II b).

Specimens (II a)

An amount of 690 g of the tunic from 120 specimens, which had been collected at Shirahama, Wakayama Pref. and stored for several months in the formalin solution, was used for materials.

Free xanthophyll fraction: Most of the red pigment in the acetone extract was changed into hypophase, from which the violet-red crude crystals were isolated. Then the pigment was washed with petroleum ether, and chromatographed on calcium carbonate from benzene solution and developed with the same solvent. Two zones resulted; the upper, a dirty red thin zone and the lower, a broad reddish pink main zone. The main adsorbed zone was cut off and the pigment was eluted with acetone, extracted with ether, and then the ether was evaporated *in vacuo*. The crystalline cake was dissolved in hot pyridine and drops of hot water were added. Then violet-red needles, melted at 205~6°C, were crystallized. For absorption spectra see Fig. 1 (II a, 505, ~540 mμ in CS_2) and Fig. 3 (II a, 493, ~520 mμ in $CHCl_3$). It was soluble in chloroform, carbon disulphide and pyridine but sparingly in petroleum ether and ether. CARR-PRICE reaction (+) violet, conc. H_2SO_4 reaction (+) blue, aqueous HCl reaction (−).

The yield was about 1 mg. The pigment showed hypophasic property (P. E./90% MeOH) and changed into an upper layer when a little water was added. When alkali was added, however, the pigment remained in the lower layer and was deposited interface. After that, the pigment changed into epiphase, when it was acidified by acetic acid. These properties indicate that this pigment is a ketonic carotenoid.

Specimens (II b).

An amount of 380 g of the tunic from the 11 specimens collected at Maezima Island, Ushimado, and stored for twenty days in the formalin solution in a dark place, was used for materials.

Free Xanthophylls: The major pigments were found in the hypophasic 90% methanol phase, from which the violet-black crystals were separated. The yield was about 4 mg. The crystals were dissolved in 15 c.c. of hot ethanol and added 2N ethanolic potassium hydroxide and then allowed to stand for 3 hours. Then a layer of petroleum ether was added and diluted with water and then acidified with 50% acetic acid. The black violet crystals, which were separated at the boundary of the two layers, were crystallized from pyridine-water (Plate XII, fig. 2). The yield was only about 1 mg. The properties of the crystal were as follows; m. p. 194~6°C, absorption maxima, 500~506, ~540 mμ in carbon disulphide (Fig. 1, II b), 488~494, ~514 mμ in pyridine, easily soluble in carbon disulphide, chloroform, pyridine, sparingly soluble in ethanol, petroleum ether and ether, hypophasic property (P. E./90% MeOH), CARR-PRICE reaction (+) violet, conc. H_2SO_4 reaction (+) blue, conc. HCl reaction (−) and had a ketonic property.

Carotenoids in epiphase: This fraction was divided into two fractions; carotenoid hydrocarbons (A) and xanthophylls (B) derived from xanthophyll esters by saponification.

Both fractions were poor in pigments. Fraction (A) in the petroleum ether solution was chromatographed on alumina (Merck) and developed with petroleum ether containing acetone (1 and 5%). Three zones, the upper red zone (i), the intermediate light yellow zone (ii) and the lower light pink orange zone (iii) were formed. The absorption spectra of the pigment which was eluted from zone (i) and (iii) were shown in the Fig. 4. The pigment of zone (i) was unable to elute completely with acetone containing acetic acid.

Zone (i) ~390, ~460, 483 mμ CS_2.
Zone (iii) 390, ~450, 478, ~510 mμ CS_2.

Fraction (B) in ethereal solution was chromatographed on alumina and developed with petroleum ether containing acetone (10%). Three zones, the upper dark-red zone (i), the intermediate red zone (ii) and the lower yellow zone (iii) were formed.

The absorption spectrum of the pigment which was eluted with acetone containing acetic acid from the main zone (i), showed the maximum at ~490 mμ in carbon disulphide (Fig. 4, I').

The results derived from the (fresh) specimens (II b), were used for the data of the pigments of the *Pyura michaelseni*.

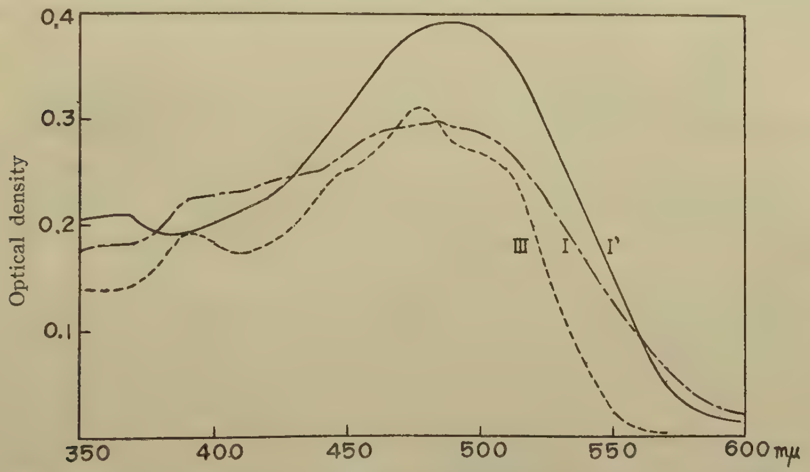

Fig. 4. Absorption spectra of the epiphasic carotenoids in *P. michaelseni* (specimens II b).

(I), carotenoid hydrocarbon, zone i.
(III), carotenoid hydrocarbon, zone iii.
(I'), a xanthophyll derived from xanthophyll ester.

III. *Styela plicata* (Japanese name, Shiroboya)

An amount of 160 g of the light dark red pigmented tunic from 40 specimens of *Styela plicata* collected at Shirahama, Wakayama Prefecture and stored for ten days in the formalin solution, was used for extraction. The acetone extract showed greenish dark orange in colour and the pigments were divided into two fractions; the brown green epiphase having light red fluorescence, and the dark orange hypophase by shaking with 90% methanol.

Free xanthophylls: Any attempt to crystallize the pigment from the hypophase which contains the most red pigment, failed.

The amorphous red materials separated on the surface between the diluted hypophase and the additional petroleum ether layer, however, were washed with petroleum ether and dissolved in benzene and then, chromatographed on alumina (not adsorbed on $CaCO_3$ or $ZnCO_3$) and developed with benzene. Two zones, the upper, a dirty brown main zone and the lower, a dirty greenish brown zone which was just under the main zone, resulted. The lower zone moved down slightly but the upper zone did not move when the column was developed with petroleum ether containing acetone (5%). The pigment of the upper zone was eluted with acetone and extracted with ether. Any attempt to crystallize failed. The absorption maxima of this pigment showed at (~410), ~435, 460, ~490 mμ in chloroform (Fig. 3, III). CARR-PRICE reaction (+) blue, conc. H_2SO_4 reaction (+) blue, aqueous conc. HCl reaction (−).

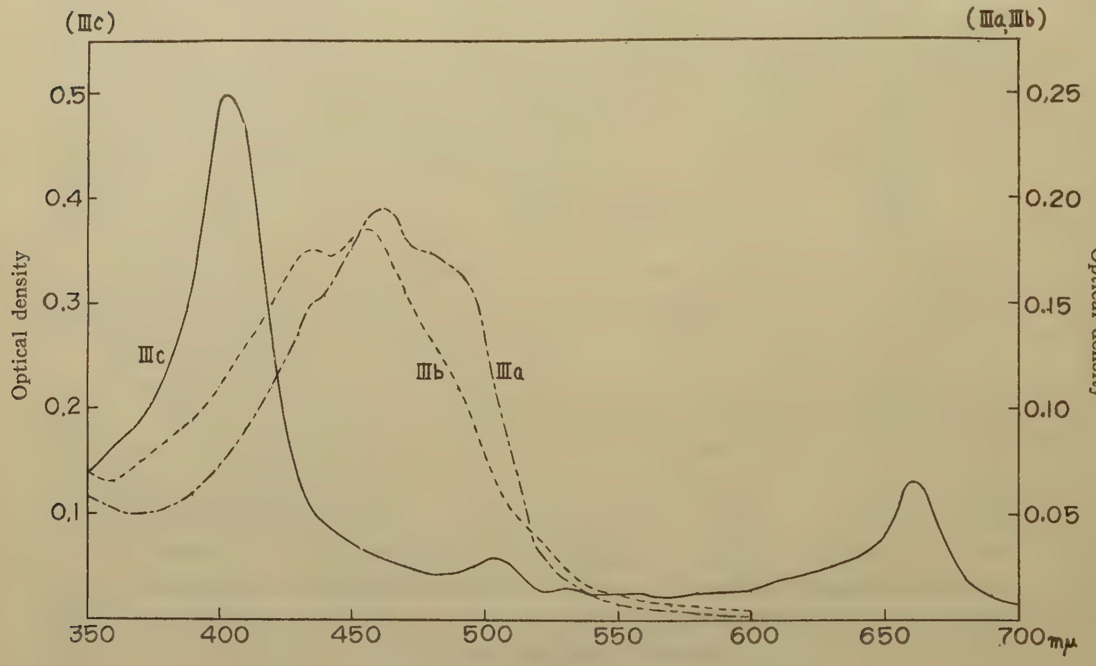

Fig. 5. Absorption spectra of the pigments in *S. plicata*.

(III a), carotenoid hydrocarbon, zone IV.
(III b), a xanthophyll derived from xanthophyll esters.
(III c), green pigment in alkaline equeous ethanol.
(III a and III b in $CHCl_3$)

Carotenoids in epiphase: The epiphase was divided into three fractions; the yellow petroleum ether solution (A) containing carotenoid hydrocarbons, the yellow ethereal solution (B) containing xanthophylls derived from xanthophyll esters and the greenish aqueous alcoholic alkaline solution (C) after saponification. Fraction (A) was chromatographed on alumina and developed with petroleum ether. Four zones beginning at the top of the column resulted; the dark violet red (i), the orange red (ii), the reddish orange (iii) and the broad orange red main zone (iv). Zone (iv) was moved down slowly forming a thin zone when the column was developed with petroleum ether containing acetone (2%). The pigment of (iv) was eluted with acetone and after evaporation of acetone *in vacuo*, the pigment was dissolved in chloroform and the absorption maxima were determined. The maxima showed at ~435, 462, ~490 mμ. (Fig. 5, III a). CARR-PRICE reaction (+) blue.

Fraction (B) was chromatographed on alumina from benzene solution and developed with acetone-petroleum ether mixture (1:1). Two zones, the orange thin zone forming at the top of the column, and the lower light yellow broad zone, were formed. The pigment of the latter was washed out with acetone and dissolved in chloroform after the evaporation of acetone. The absorption maxima of the latter showed at 437, 456 mμ. (Fig. 5, III b). CARR-PRICE reaction (+) blue. Fraction (C) showed the absorption maxima at 402, 503, 660 mμ (Fig. 5, III c). The highest maximum laying at 402 mμ shows that the principal pigment of fraction (C) belongs to the porphyrin pigment.

IV. *Amaroucium pliciferum* (Japanese name, Manzyuboya)

The whole bodies (680 g) of the 27 living specimens collected at Maezima Island, Ushimado, Okayama Prefecture, were treated with acetone.

Free xanthophyll fraction: Most of the red pigments were found in the hypophase (blood red), from which the major carotenoid was crystallized in the form of violet needles.

Then the crystals were chromatographed on alumina from ethereal solution and developed with ether containing acetone (0.2%). Three zones, the uppermost, red orange zone (i), the intermediate, carmine red orange zone (ii), and the lower, bright orange main zone (iii) were formed.

The pigment of (iii) was eluted with acetone-ether mixture (1:1) and the crystalline materials (about 2.8 mg) were rechromatographed on zinc carbonate from benzene solution and developed with benzene and ether.

Then the single zone, which moved down slowly, was formed and the pigment was eluted with acetone and crystallized from the hot pyridine.

The properties of the crystal were as follows; orange needle (Plate XII, fig. 3), m.p. 166°C, absorption maxima at 479, 503 mμ in carbon disulphide (Fig. 1, IV), CARR-PRICE reaction (+) blue, conc. H_2SO_4 reaction (+) blue, aqueous conc. HCl reaction (−). It was soluble in chloroform, benzene, carbon disulphide, pyridine, and sparingly soluble in petroleum ether. The pigment showed hypophasic property but showed epiphasic when it was treated with acetic acid anhydride and pyridine to form ester. After saponification of the ester, however, the pigment returned to hypophase. Thus, this pigment has more than one OH group.

Carotenoids in epiphase: Both fractions, the carotenoid hydrocarbons (A) and the esterified xanthophylls (B) were poor in pigment.

The pigments of (A) in petroleum ether were chromatographed on alumina and developed with petroleum ether containing acetone (5%). The light pink brown zone (absorp. max. 465, (~510) mμ in CS_2) (Fig. 6, IV a) was formed and the yellow coloured filtrate showed the absorption maxima at 475, ~495 mμ in carbon disulphide. (Fig. 6, IV b).

The pigments of (B) in ethereal solution were chromatographed on zinc carbonate and developed with ether. The pink brown zone (absorp. max. 465 mμ in CS_2) (Fig. 6, IV c) which moved down gradually, was formed and the bright yellow filtrate showed no selective visible light absorption (Fig. 6, IV d).

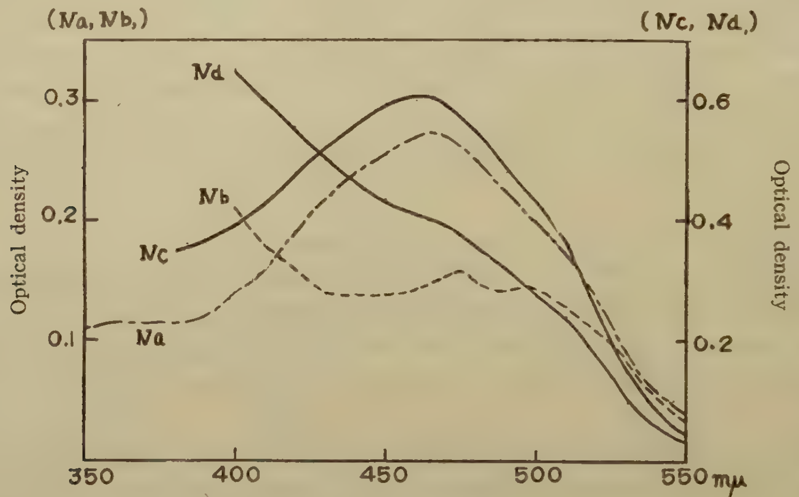

Fig. 6. Absorption spectra of the carotenoids in *A. pliciferum*.

(IV a) an adsorbed and (II b) non-adsorbed carotenoid hydrocarbon fraction, (IV c) an adsorbed and (IV d) non-adsorbed xanthophyll fraction derived from their esters, in carbon disulphide.

Summary

Some comparative studies of the pigments of four species of tunicates, *Halocynthia roretzi* (I), *Pyura michaelseni* (II), *Styela plicata* (III) and *Amaroucium pliciferum* (IV), have been carried out.

The major pigment of each species was a free xanthophyll (phytoxanthin), which was isolated in the crystalline form from the specimens of (I), (II) and (IV).

The principal carotenoid of four species was different each other (Table 3). From the dark red tunics of *Halocynthia roretzi* (I), astacene and a free xanthophyll which is recognized to cynthiaxanthin have been isolated as predominant carotenoid. Cynthiaxanthin is a unique xanthophyll which has been isolated from the dark red tunic of *Halocynthia papillosa* by LEDERER (1934), who recovered 1 mg of the cynthiaxanthin accompanied with 4 mg of astacene from fifteen specimens. KARRER and SOLMSSEN (1935), however, could not detect cynthiaxanthin from the same species.

Astacene of (I) was recovered from the free astaxanthin occurring in the tunic.

The principal carotenoid in the reddish purple tunic of *Pyura michaelseni* (II) is a free xanthophyll which melted at 194∼6°C and showed absorption maxima at 500∼506, ∼540 mμ in carbon disulphide, 488∼494, ∼514 in pyridine. It has a ketonic property.

The pigment of the light dark red tunic of *Styela plicata* (III) was extracted with acetone and the extract contained carotenoids and the pigment appeared to be porphyrin pigment. No crystalline pigment has been obtained from both fractions, but the absorption spectra of the principal carotenoid of the former, which refined chromatographically, showed the maxima at (∼410), ∼435, 460, ∼490 mμ in chloroform, and the latter showed at 402, 503, 660 mμ in alkaline aqueous ethanol solution.

From the whole acetone extract of *Amaroucium pliciferum*, a brilliant red pigmented colony tunicate, a free xanthophyll having absorption maxima at 479, 503 mμ in carbon disulphide and melting at 166°C, has been isolated.

Moreover, spectrophotometric examinations on the accompanying small amounts of carotenoid hydrocarbons and esterified xanthophylls in each species, were carried out.

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EXPLANATION OF PLATE XII

Fig. 1. Cynthiaxanthin isolated from *Halocynthia roretzi*.

Fig. 2. Principal hypophasic carotenoid isolated from *Pyura michaelseni* (II b).

Fig. 3. Principal hypophasic carotenoid isolated from *Amaroucium pliciferum*.

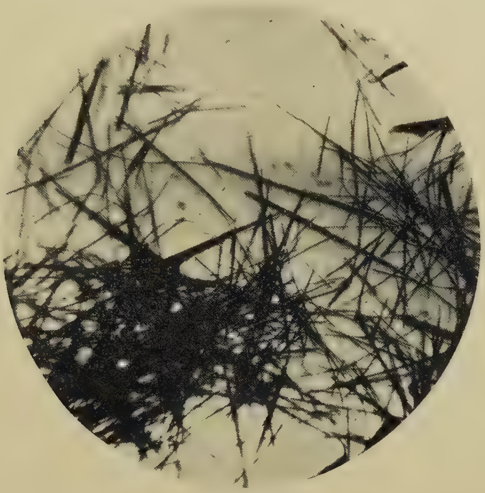

Fig. 1.

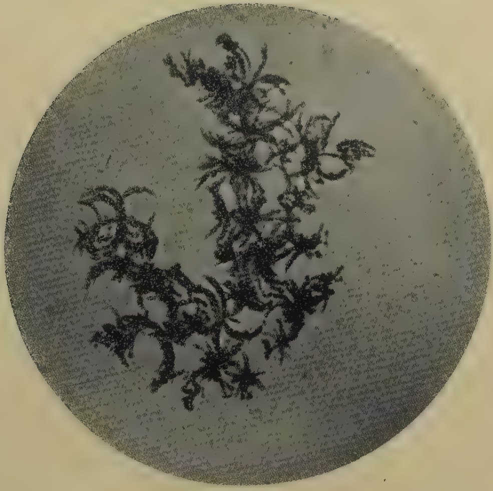

Fig. 2.

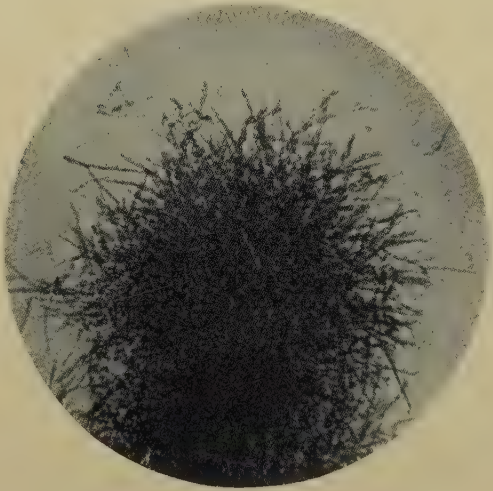

Fig. 3.

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PYCNOGONIDA OF SAGAMI BAY[1]

HUZIO UTINOMI
Seto Marine Biological Laboratory, Sirahama

With 9 Text-figures

The present paper deals with the Pycnogonida from the collections in the Biological Laboratory of His Majesty the Emperor in Tokyo which have been assembled from Sagami Bay during the period from 1928 to 1958.

Although the pycnogonid collection is not extensive, only comprising 43 vials, it was revealed to represent 18 species belonging to 11 genera in all. Most of them are endemic to or common in Japanese waters, but a few which have been known only from southern tropical waters are added for the first time to the Japanese fauna. Moreover, the present collection revealed some remarkable examples, interesting from a taxonomic point of view, necessitating an emendation of some generic or specific characters in some genera of the Ammotheidae.

The pycnogonid fauna in Sagami Bay and the neighboring waters is locally better known than in other areas of Japan, thanks to the works by Japanese authors (FUKUI, KISHIDA, OHSHIMA and UTINOMI) and several foreign authors (BÖHM, SLATER, HOEK, IVES, ORTMANN, LOMAN, HELFER, HEDGPETH and STOCK). Earlier records of pycnogonids from this district by these investigators are given at the end of this paper in order to summarize our present knowledge of the pycnogonid fauna of Sagami Bay.

I am greatly indebted to Dr. Hirotaro HATTORI of the Biological Laboratory of His Majesty the Emperor and staff members for the privilege of studying this interesting collection.

In the following list the species marked with an asterisk (*) are now newly added to the Japanese fauna.

Family Nymphonidae
  Nymphon grossipes (O. FABRICIUS ?) KRØYER
  Nymphon japonicum ORTMANN
Family Callipallenidae
  Propallene longipes (BÖHM)
  Pallenopsis sibogae LOMAN

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[1] Contributions from the Seto Marine Biological Laboratory, No. 323.

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Pallenopsis virgata LOMAN
Family Phoxichilidiidae
**Anoplodactylus versluysi* LOMAN
Family Ammotheidae
Achelia echinata HODGE
Achelia superba LOMAN
**Ammothella indica* STOCK
Nymphopsis muscosa LOMAN
Cilunculus armatus (BÖHM)
Ascorhynchus japonicum IVES
Ascorhynchus auchenicum (SLATER)
Ascorhynchus ramipes (BÖHM)
Ascorhynchus glaberrimum SCHIMKEWITSCH
Lecythorhynchus hilgendorfi (BÖHM)
**Lecythorhynchus hedgpethi* n. sp.
Family Pycnogonidae
Pycnogonum tenue KISHIDA

Description of the Species

Family Nymphonidae

Genus *Nymphon* J. C. FABRICIUS, 1794

1. *Nymphon grossipes* (O. FABRICIUS ?) KRØYER

Nymphon grossipes HEDGPETH, 1948, p. 187, fig. 13a; HEDGPETH, 1949, p. 247 (synonymy); UTINOMI, 1955, p. 4, fig. 1; STOCK, 1955, p. 218.

Material: 1 male (Sp. No. *Pycn.* 6). 100 m east of Okinose Bank1). Depth unrecorded. 4-VIII-1936.

1 female (Sp. No. *Pycn.* 38). Mosaki, Kamegisyô, 8 fathoms. 24-VIII-1957.

Remarks: This circumpolar, boreal-arctic species was already collected off Simoda by the 'Sôyô-maru' (UTINOMI, 1955).

Measurements of a male and a female in mm:

	Male (no. 6)	Female (no. 38)
Length of proboscis	3.0	2.5
Diameter of proboscis	—	0.7
Length of trunk	6.0	2.5
Width of trunk (excl. crurigers)	—	0.5
Length of crurigers	—	0.3
Length of abdomen	1.0	0.2
Space between crurigers	—	0.3

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1) Localities in the succeeding text are all included in Sagami Bay.

2. *Nymphon japonicum* Ortmann

Nymphon japonicum Ortmann, 1890, p. 158, pl. 24, fig. 1 (part); Hedgpeth, 1949, p. 249, fig. 20; Utinomi, 1951, p. 159; Stock, 1954, p. 18, fig. 6a–e; Utinomi, 1955, p. 5.

Material: 7 males (Sp. No. *Pycn.* 17). Maruyama-dasi, Amadaiba, 218 m. 19-VII-1952.

1 male (Sp. No. *Pycn.* 26). West of Aoyama-dasi, Amadaiba, 110 m. 15–III-1956.

Remarks: This is prevalent and apparently endemic in Japanese waters.

Family Callipallenidae

Genus *Propallene* Schimkewitsch, 1909

3. *Propallene longiceps* (Böhm)

Pallene longiceps Böhm, 1879b, p. 59; Ortmann, 1890, p. 165, pl. 24, fig. 7; Fukui, 1918, p. 99; Ohshima, 1933a, p. 96; Ohshima, 1933c, p. 212, figs. 1–7.

Propallene longiceps Schimkewitsch, 1930, p. 282 (1929, fig. 3); Ohshima, 1936, p. 863 (listed only); Stock, 1954, p. 31, fig. 12a–b.

Material: 1 male and 1 female (Sp. No. *Pycn.* 23). Off Simoda, 20 m. ?-XI-1954.

Remarks: In a male specimen, a pair of rudimentary 2-jointed palps are present on the ventral side at the base of chelifores, as figured by Schimkewitsch and Ohshima. It is rather robust and shorter than that of the allied *P. kempi* (Calman), as noticed by Stock (1954). In a female specimen, the femur of all legs is plump, fusiform, containing 2 or 3 orange-colored eggs.

This species seems to be endemic to Japanese waters at present, and has often been recorded. The present material, brownish in color, is apparently benthic, but as exemplified by Ohshima (1933a, c) this is often found in plankton. Indeed, I have found this species in plankton samples collected by Dr. I. Yamazi during his plankton investigation in bays along the Japanese coasts (9 specimens from Kamaisi Bay of Tôhoku district on September 30, 1952; 12 specimens from Tanabe Bay of Kii district in September, 1956).

Genus *Pallenopsis* Wilson, 1881

4. *Pallenopsis sibogae* Loman

Pallenopsis sibogae Loman, 1911, p. 14; Stock, 1954, p. 63, fig. 30h–i (synonymy); Utinomi, 1955, p. 19, fig. 11.

Material: 1 female (Sp. No. *Pycn.* 7). South of Zyôgasima, 70 fathoms. 8-VIII-1936.

1 female, damaged (Sp. No. *Pycn.* 18). Maruyama-dasi, Amadaiba, 80 m. 21-VII-1952.

Remarks: This is the third record of occurrence in Japan. Formerly STOCK (1954) recorded from the west of Kyusyu, 90 fms. and UTINOMI (1955) from Suruga Bay, 79 m.

5. *Pallenopsis virgata* LOMAN

Pallenopsis virgatus LOMAN, 1908, p. 69, pl. 9, fig. 134; pl. 10, figs. 135–136; HEDGPETH, 1949, p. 277, fig. 36g–h; UTINOMI, 1951, p. 160.

Material: 1 male (Sp. No. *Pycn.* 13). Haikosine, 30–32 m. 8–VIII–1950.

Measurements of a male in mm:

Length of proboscis	2.5
Length of trunk	5.0
Length of abdomen	1.5
Length of crurigers	1.5
Length of 4th leg	25.0

Remarks: As in the preceding *sibogae*, there is a rounded tubercle below the basis of the chelifore as a vestige of palp. The presence of paired tubercles on the dorso-distal end of coxa 1 and a strong protuberance on the ventro-distal end of coxa 2 is characteristic to this species.

Hitherto records in Japanese waters are from the southwest of Omaé-zaki, 34–37 fathoms ('Albatross' Station 3730) and from off Yuzaki, Kii Peninsula, 25–35 m.

Family Phoxichilidiidae

Genus *Anoplodactylus* WILSON, 1878

6. *Anoplodactylus versluysi* LOMAN

Anoplodactylus versluysi LOMAN, 1908, p. 73, pl. 3, figs. 33–39; STOCK, 1954, p. 48, figs. 38a, 39.

Material: 1 female (Sp. No. *Pycn.* 28a). Aoyama-dasi, Amadaiba, 70–90 m. 15–VI–1956.

1 young male (Sp. No. *Pycn.* 31). Kannonzuka-dasi, Amadaiba, 66–75 m. 14–II–1957.

Remarks: Two specimens, both female and young male, largely coincide with the description of *A. versluysi* by LOMAN (1908) and STOCK (1954), although a few differences are found.

In a female specimen, the oviger is lacking, but its vestige is seen inserting between the bases of the first leg and the proboscis. Lateral processes are widely separated by twice their own diameter. On the ventral surface of the proboscis there is found a large, somewhat conical, mound instead of 4 papillae (such as figured by STOCK). The ocular tubercle is sharply pointed at tip and with 4 well-pigmented eyes rather downwards. Of the legs, coxa 1 is armed with a spiny tubercle at the dorso-distal end.

In a young male, the characteristic tubercle on the ventral surface of the proboscis is indistinct, as LOMAN neither mentioned nor figured. Probably such variation in the ventral outgrowth of the proboscis may be dependant on the sexual difference. The oviger is short and unsegmented. However, the presence of a peculiar tall ocular tubercle and a spiny tubercle on the distal end of coxa 1 indicates to be identical.

Measurements of a young female in mm:

Length of proboscis	1.0
Length of trunk	2.5
Length of abdomen	0.5

Family Ammotheidae

Genus *Achelia* HODGE, 1864

7. *Achelia echinata* HODGE

(Fig. 1)

Achelia echinata UTINOMI, 1954, p. 11, figs. 4–5 (synonymy).
Achelia echinata ssp. *nasuta* STOCK, 1956, p. 98, fig. 16a (synonymy).

Material: 1 male and 2 ovigerous males (Sp. No. *Pycn.* 5a). 30 m south of Enosima. Depth unrecorded. 27–II–1938.

1 male (Sp. No. *Pycn.* 16). Sabane, off Hayama. Depth unrecorded. 26–VII–1929.

1 male (Sp. No. *Pycn.* 21). Kasazima, shallow water. 22–VII–1952.

2 ovigerous males (Sp. No. *Pycn.* 35). Mosaki, Kamegisyô, 7–8 fathoms. 19–VII–1957.

Remarks: All the material from Sagami Bay agree well with the specimens from Akkeshi Bay, Hokkaido (UTINOMI, 1954, p. 11) and those from Tsingtao, North China which were described under the varietal name var. *sinensis* (LOU, 1936a, p. 19, figs. 7–9, pls. II–IV).

In naming the specimen (a female) obtained off the Marine Biological Station, Misaki, 200 fathoms, STOCK (1956, p. 98) adopted a subspecific name *nasuta* MARCUS, 1940 (substitute for ssp. *orientalis* LOSINA-LOSINSKY, 1933).

The typical form of *Achelia echinata* HODGE is widely distributed in the North Atlantic waters as far south as the Cape Verde Islands. Recently STOCK (1955) recorded it from St. Croix, West Indies. It was not known from the western side of the Atlantic before, yet he did not detect any reliable difference between the West Indian material and the European form.

With respect to the affinity of the oriental form, LOU (1936a) lay too much stress on the relative length of the chelifore and abdomen to the trunk, as differentiating from the European form. STOCK (1956) also emphasizes the slenderness of legs and the larger size in adults of the oriental form, relative to the European form.

In my opinion, however, such differences in size seem to be less reliable for exact discrimination of many individuals from different localities. Even if such differences are recognizable as constant, the proposal of *nasuta* by Marcus (1940) to cover the Losina-Losinsky's homonymy is unnecessary, since Lou's var. name *sinensis* precedes Marcus' ssp. name *nasuta*.

As to another form *Achelia echinata* var. *japonica*, briefly described by Ortmann (1890) from Kadsiyama (=Katuyama), mouth of Tokyo Bay, I already suggested that it is not identical with *Achelia echinata*.

According to Ortmann's figure (pl. 24, fig. 6), the proboscis is plump, nearly oval instead of being pointed distally, the chelifore relatively very short, the trunk as long as wide, well-segmented, without tubercles and the abdomen very short, almost hidden below. It may be, if distinct, allied to either *A. bituberculata* Hedgpeth or *A. ohshimai* Utinomi more closely than to other species. Rediscovery of new material will decide its status finally.

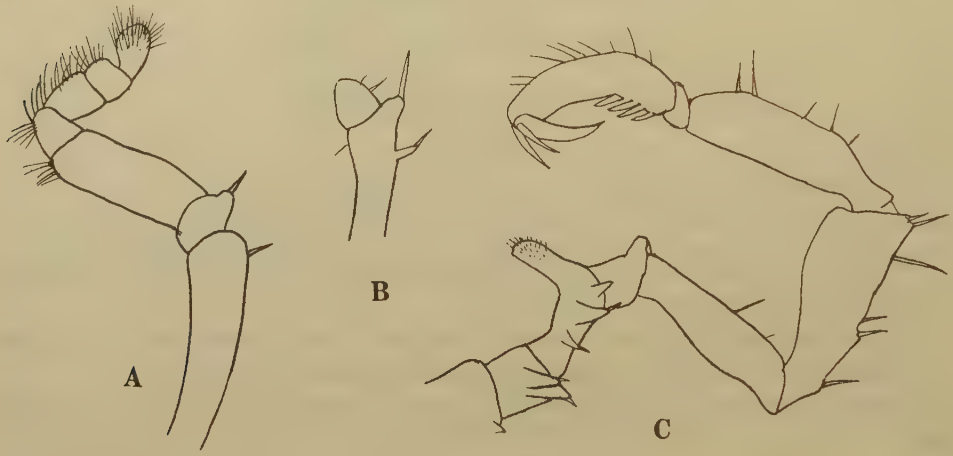

Fig. 1. *Achelia echinata* Hodge.
A, palp; B, chelifore; C, fourth leg of male (Sp. No. 35).
(A-B 15, C ×35)

Achelia echinata seems to be essentially a boreal species ubiquitous in the northern hemisphere. Its range can be extended to the eastern Mediterranean (Stock, 1958, p. 1) and to the Red Sea (Calman, 1938, p. 160).

8. *Achelia superba* (Loman)

Ammothea superba Loman, 1911, p. 11, pl. 1, figs. 14-15 & pl. 2, figs. 16-24; Fukui, 1918, p. 98 (listed only); Ohshima, 1936, p. 866 (listed only).

Achelia superba Hedgpeth, 1949, p. 287; Utinomi, 1951, p. 160; Stock, 1954, p. 96; Utinomi, 1955, p. 23, fig. 13.

Material: 1 male (Sp. No. *Pycn.* 15). Kannonzuka-dasi, Amadaiba, 70 m. 13–XI–1950.

1 ovigerous male (Sp. No. *Pycn.* 19). Maruyama-dasi, Amadaiba, 80 m. 12–VII–1952.

1 male (Sp. No. *Pycn.* 28b). Aoyama-dasi, Amadaiba, 70–90 m. 15–VII–1956.

2 males (Sp. No. *Pycn.* 34). Aoyama-dasi, Amadaiba, 74–86 m.

1 male (Sp. No. *Pycn.* 42). Kannonzuka-dasi, Amadaiba, 65–72 m. 19–XII–1958.

8 ovigerous males (Sp. No. *Pycn.* 43). Between Kannonzuka-dasi and Aoyama-dasi, Amadaiba, 75–82 m. 19–XII–1958.

Remarks: This deep-water species unique for the genus has been frequently collected in Sagami Bay, ranging from 37 m to 180 m in depth.

Genus *Ammothella* VERRILL, 1900

9. *Ammothella indica* STOCK

(Figs. 2 & 3)

Ammothella indica STOCK, 1954, p. 113, figs. 54–56c, 57a–c.

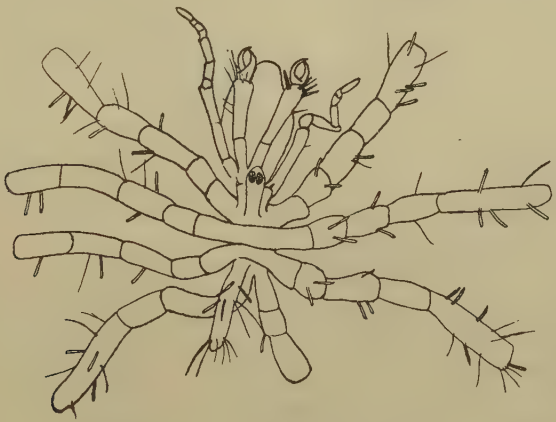

Fig. 2. *Ammothella indica* STOCK.
Immature specimen (Sp. No. 5), distal joints of legs omitted. (×28)

Material: 2 juveniles (Sp. No. *Pycn.* 5b). 30 m south of Enosima. Depth unrecorded. 8–VIII–1936.

Remarks: Two immature specimens obtained in Sagami Bay, only 2.3 mm in total length from the tip of proboscis to the end of abdomen, agree well with *Ammothella indica* STOCK (1954) recorded only from Sunda Straits (30 m deep) and Singapore (at low tide).

The trunk is distinctly segmented, with long lateral processes which are separated by about half their own diameter. The ocular tubercle is very elongated, constricted at base, with 4 well-pigmented eyes near the distal end; on each side of its base a spine-bearing protuberance (not mentioned by STOCK) is situated.

Abdomen is much long, curved upwards; in the middle and near the end there are brushes of simple and peculiar, somewhat shorter, hollow spines.

Proboscis is pyriform, widest in the middle and finely striated in rings. Chelifores, longer than proboscis, are also adorned with normal and hollow spines though loosely.

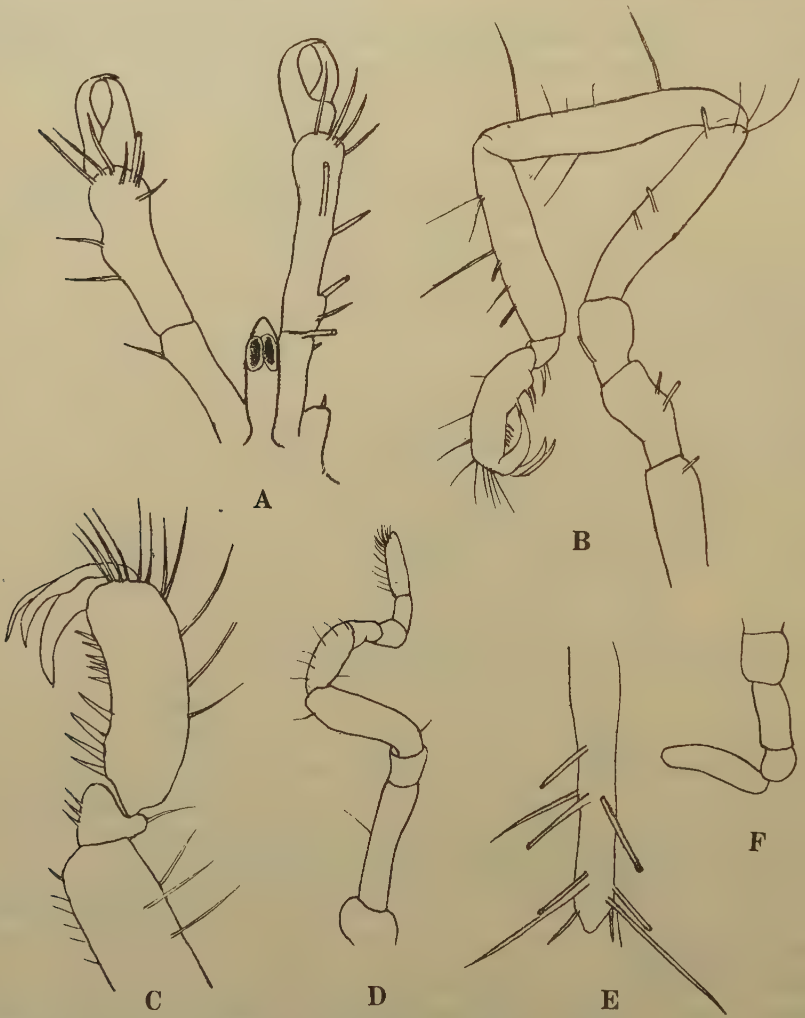

Fig. 3. *Ammothella indica* STOCK.
A, ocular tubercle and chelifores; B, fourth leg; C, distal joints of fourth leg; D, palp; E, abdomen; F, oviger still undeveloped.
(F ×28, B ×33, C ×67, A, D, E ×207)

The scape is 2-jointed, distal joint about twice as long as proximal one. The chela is still chelate, composed of strongly incurved fingers, gaping when closed.

Palpus 9-jointed, with normal spines and setae only. Oviger still undeveloped, 4-jointed only.

All legs are very slender and armed with hollow spines and normal spines rather sparsely. Propodus slender, slightly curved and with 2 or 3 basal spines and 6 or 7 smaller distal spines. Terminal claw is strong and auxilliaries slender, only a little shorter than the former.

Genus *Nymphopsis* HASWELL, 1884

10. *Nymphopsis muscosa* LOMAN

Nymphopsis muscosus LOMAN, 1908, p. 52, pl. 13, figs. 175–188; LOMAN, 1911, p. 11; FUKUI, 1918, p. 99 (listed only); OHSHIMA, 1936, p. 864 (listed only).

Nymphopsis muscosa STOCK, 1953, p. 307; STOCK, 1954, p. 121.

Material: 1 male (Sp. No. *Pycn.* 10). 600 m west of Nisinosaki, Hatune, 17 m. 29–VIII–1940.

1 ovigerous male (Sp. No. *Pycn.* 36). Mosaki, Kamegisyô, 7–8 fathoms. 16–VII–1957.

Measurements of an ovigerous male in mm:

Length of chelifore	2.0
Length of trunk	2.0
Length of abdomen	1.5

Genus *Cilunculus* LOMAN, 1908

11. *Cilunculus armatus* (BÖHM)

Cilunculus armatus UTINOMI, 1955, p. 27, fig. 16 (synonymy).

Material: 1 female (Sp. No. *Pycn.* 39). Mosaki, Kamegisyô, 8 fathoms. 24–VII–1957.

Measurements of a female in mm:

Length of chelifore	0.4
Length of proboscis	2.5
Length of trunk	3.0
Length of abdomen	1.3

Genus *Ascorhynchus* G. O. SARS, 1877

12. *Ascorhynchus japonicum* IVES

Ascorhynchus japonicum STOCK, p. 126, figs. 61–62; UTINOMI, 1955, p. 24 (synonymy).

Material: 1 ovigerous male (Sp. No. *Pycn.* 2). West of Amadaiba, 150 fathoms. 26-VII-1935.

1 male (Sp. No. *Pycn.* 3). South of Amadaiba, 150 fathoms. 8-IX-1935.

1 male (Sp. No. *Pycn.* 14). Nakabukari, off Nagai, 300 m. 8-VIII-1950.

Measurements of a large male (no. 14) *in mm*:

Length of proboscis	15.0
Length of trunk	20.0
Length of abdomen	6.5
Length of chelifore	5.0
Length of fourth leg	85.0

13. *Ascorhynchus auchenicum* (SLATER)

(Fig. 4 A)

Parazetes auchenicus SLATER, 1879, p. 281; HOEK, 1881, p. 26 (listed only).
Ascorhynchus bicornis ORTMANN, 1890, p. 162.
Ascorhynchus ramipes LOMAN, 1911, p. 9 (partim).
Ascorhynchus sp. (from Hôzyô, Prov. Awa) FUKUI, 1918, p. 97 (figured only).
Ascorhynchus minutus SCHIMKEWITSCH, 1929, p. 111, figs. 26-27 (not HOEK).
Ascorhynchus auchenicus CALMAN, 1922, p. 199, figs. 1-4; OHSHIMA, 1936, p. 864 (listed only); HEDGPETH, 1949, p. 291.
Ascorhynchus auchenicum STOCK, 1954, p. 124, figs. 59-60 (synonymy).

Material: 1 male (Sp. No. *Pycn.* 4). Maruyama-dasi, Amadaiba, 80 fathoms. 16-VIII-1936.

1 male (Sp. No. *Pycn.* 29). Aoyama-dasi, Amadaiba, 70-90 m. 22-VII-1928.

1 ovigerous male (Sp. No. *Pycn.* 30). Off west of Nityôdani, Misaki, 91 m. 19-I-1957.

Remarks: Recently STOCK (1954) discussed in detail on the dissimilarity between *As. auchenicum* and *As. minutum* HOEK known only from South Australia.

As. auchenicum appears therefore to be confined to Japanese waters at present. As STOCK suggests, *As. minutus* recorded by SCHIMKEWITSCH (1929) from Misaki is apparently an error for *As. auchenicum.*

In the present material, the median tubercles on the dorsum of the trunk are comparatively low, while the distal tubercle of the crurigers is tall and robust. In the legs, coxa 1 is provided with a pair of strong tubercles obliquely projecting at the distal end, and coxa 2 with a knob-like, low tubercle about midway on the dorsal surface.

In the posterior legs, the terminal claw is less than one-third as long as the propodus. In the anterior legs, however, it is much shorter. The abdomen reaches to the end of coxa 1 of the last legs. A pair of minute tubercles which are not so prominent as the paired frontal tubercles on the head are seen on the dorsal surface of the stalk of proboscis.

Measurements of a male (no. 29) *in mm*:

Length of proboscis	5.0	Length of chelifore	1.5
Length of trunk	8.0	Width of trunk (excl. crurigers)	0.7
Length of abdomen	1.9	Space between crurigers	1.0
Length of crurigers	1.5	Diameter of crurigers	0.5

14. *Ascorhynchus ramipes* (Böhm), syn. nov.

(Fig. 4B)

Gnamptorhynchus ramipes Böhm, 1879b, p. 56, fig. 1.

Ascorhynchus ramipes Hoek, 1881, p. 25 (listed only); Ortmann, 1890, p. 161, pl. 24, fig. 4; Loman, 1911, p. 6 (partim); Fukui, 1918, p. 98 (listed only); Ohshima, 1936, p. 865 (listed only); Hedgpeth, 1949, p. 292.

Ascorhynchus ramipes var. *tsingtaoensis* Lou, 1936a, p. 3, figs. 2–6, pl. 1, figs. 1–10; Ohshima, 1936, p. 865 (listed only).

Ascorhynchus latus Calman, 1923, p. 270, figs. 2-3.

Ascorhynchus latum Stock, 1954, p. 128, fig. 63a–c.

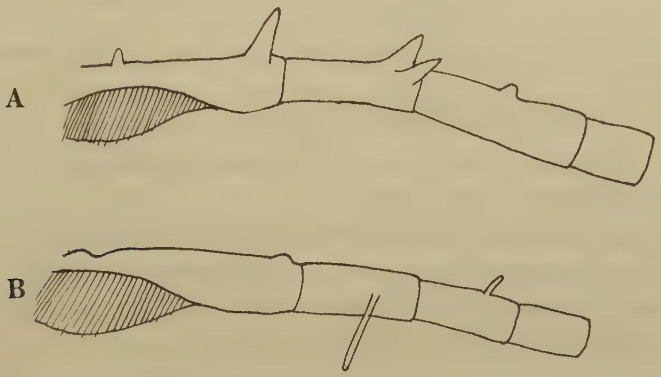

Fig. 4. Diagrammatic figures of crurigers and proximal joints of legs, showing the arrangment of tubercles and finger-like process in *Ascorhynchus auchenicum* (A) and *As. ramipes* (B), lateral view from back.

Material: 2 males (Sp. No. *Pycn.* 8). Issiki, Hayama, 6 fathoms. 11–I–1930.

1 male and 1 ovigerous male (Sp. No. *Pycn.* 9). Issiki, Hayama, 6 fathoms. 19–I–1930.

3 males and 3 ovigerous males (Sp. No. *Pycn.* 12). Off Kuruwa, 15–16 fathoms. 13–II–1950.

Remarks: All the specimens agree well with Lou's detailed descriptions of *As. ramipes* var. *tsingtaoensis* from North China and also of Calman's *As. latus* from the Gulf of Manaar, India and the Gulf of Siam, both of which are undoubtedly synonyms of *As. ramipes* (Böhm) originally described from Sagami Bay. Possibly both synonymies were deriven from Böhm's deficient description of the type specimen.

This species seems to be nearly related to the preceding *auchenicum*. Yet it may be easily distinguished by the following characteristics:

The median tubercles on the trunk-dorsum are rather blunt, the distal tubercle on the crurigers are also knob-like. Of all the legs, coxa 1 is armed with a pair of finger-like processes extending horizontally near the distal end and coxa 2 with a shorter finger-like process dorsally projecting near the distal end. And also, the claw is absent in the first legs. A pair of small frontal tubercles are present on the head, but none on the dorsal surface of the stalk of the proboscis.

As all earlier records show, this species is apparently a shallow-water dweller and widely distributed in the Indo-West Pacific area.

Measurements of a male (No. 8) *in mm*:

Length of proboscis	3.0	Width of trunk (across 2nd crurigers)	3.0
Length of trunk	5.5	Width of trunk (excluding crurigers)	0.7
Length of abdomen	2.5	Diameter of crurigers	1.5
Length of crurigers	1.0		

15. *Ascorhynchus glaberrimum* SCHIMKEWITSCH

Ascorhynchus glaberrimus SCHIMKEWITSCH, 1929, p. 107, figs. 23–25; OHSHIMA, 1936, p. 865 (listed only).
Ascorhynchus glaberrimum UTINOMI, 1955, p. 26, fig. 15.

Material: 2 males (Sp. No. *Pycn.* 44). Between Kannonzuka-dasi and Aoyama-dasi, Amadaiba, 76–78 m. 22-XII-1958.

Remarks: In the present two specimens, the dorsum of the trunk is destitute of median tubercles, 4 eyes near the tip of the ocular tubercle are non-pigmented and the terminal claw is small in the first legs. In the chelifores, the chelae are reduced to a minute rudiment, but the scape is short and robust.

Measurements of a male in mm:

Length of proboscis	3.0	Diameter of proboscis	1.5
Length of trunk	5.0	Length of crurigers	1.0
Length of abdomen	1.3	Length of chelifore	0.7

Genus *Lecythorhynchus* BÖHM, 1879

Corniger BÖHM, 1879a, p. 187 (name preoccupied).
Lecythorhynchus BÖHM, 1879c, p. 140; HOEK, 1881, p. 27; COLE, 1904, p. 259, SCHIMKEWITSCH, 1929, p. 48; HELFER & SCHLOTTKE, 1935, p. 295; HEDGPETH, 1949, 294; STOCK, 1954, p. 139.

Emended diagnosis of the genus: Trunk slender, distinctly segmented with well-chitinized sutures. Legs slender, almost smooth, not much setigerous, with prominent chitinous septa or thickenings running dorso-medially in coxa 1 and laterally in the rest. Crurigers widely separated. Abdomen moderately robust. Proboscis cylindrical. Chelifore 1- or 2-jointed in adult; chela either reduced or present; if any, chelate or achelate. Palp long, 9 jointed, with S-like curved distal joints. Ovigers 10-jointed, with smooth or feebly denticulate spines. Propodus of all legs produced distally, claw strong, auxilliaries large.

Genotype: *Lecythorhynchus hilgendorfi* (Böhm).

Remarks: As discussed in detail by Stock (1954, p. 141) under the genus *Tanystylum*, the genus *Lecythorhynchus* is closely related to *Achelia*, but differs from it in the one-jointed chelifores in adults, 9-jointed palps and well-segmented, elongate body, as far as the earlier known species are concerned. However, the finding of a new unique species (*L. hedgpethi* as here named), having 2-jointed palps in adults necessitates an emendation of the generic diagnosis.

The lobe-like extension in the 5th joint of the palps has been considered as a specific characteristics in *L. marginatus* Cole. It is unusually developed in a new species *L. hedgpethi* and probably *L. ovatus* Hilton (if distinct). Probably its strong development concerns with the distortion of the flagellum-like distal joints, and therefore it may deserve one of the generic characteristics of *Lecythorhynchus*, as already recognized by Loman (1911, p. 9). Again, none of such special process for the genital opening as usually exists in *Achelia* is found in the 2nd coxae of legs. The structure of oviger spines and their arrangement resemble most closely those of *Tanystylum*. In these respects, *Lecythorhynchus* seems to be more related to the genus *Tanystylum* than to the genus *Achelia* within the Ammotheidae.

On the other hand, the conformation of the body and legs recalls the other families such as Nymphonidae, Phoxichilidiidae and Colossendeidae in the slenderness and the almost smoothness and also in the formation of distinct chitinous septa or thickenings along the mid-dorsal line in the first coxae and along the mid-lateral lines in the succeeding joints of all legs, though interruptedly in the middle of each joint.

The 3 species of the genus known at present are keyed as follows:

1 a) Chelifore 1-jointed, reduced in adults, though 2-jointed in larvae. 2
1 b) Chelifore 2-jointed, well developed in adults; body and legs not pigmented .... *L. hedgpethi* n. sp.
2 a) Body and legs banded by dark brownish patterns; 5th joint of palps more or less inflated ventrally.. *L. hilgendorfi* (Böhm) (=*L. marginatus* Cole)
2 b) Body and legs darkly pigmented; 5th to 7th joints bearing each a ventral lobe (if distinct) .... *L. ovatus* Hilton

16. *Lecythorhynchus hilgendorfi* (Böhm) Böhm, syn. nov.

(Figs. 5 & 6)

Corniger hilgendorfi Böhm, 1879a, p. 187, pl. 2, figs. 3–3d.

Lecythorhynchus hilgendorfi Böhm, 1879c, p. 140.

Lecythorhynchus hilgendorfi Loman, 1911, p. 8, pl. 2, figs. 28–29; Ohshima, 1927a, p. 610, figs. 1–3; Ohshima, 1027b, p. 380, pl. 7, figs. 1–6; Schimkewitsch, 1929, p. 54, figs. 10–11; Ohshima, 1936, p. 867 (listed only); Lou, 1936b, p. 133, figs. 1–4, 5A & pls. 11–13;

OHSHIMA & KISHIDA, 1947, p. 1009, fig. 2864; HEDGPETH, 1949, p. 296, fig. 44a–b; UTINOMI, 1951, p. 166; UTINOMI, 1954, p. 22.

Lecythorhynchus marginatus COLE, 1904, p. 260, pl. 11, figs. 1–2 & pl. 15, figs. 1–8; SCHIMKEWITSCH, 1929, p. 50, figs. 7–9; SCHMITT, 1934, p. 69; HELFER, 1938, p. 184; HILTON, 1939a, p. 34; HILTON, 1939b, p. 73, pl. 2, fig. 10; HEDGPETH, 1941, p. 255 (keyed and figured); HILTON, 1943b, p. 4; HEDGPETH, 1951, p. 111; HEDGPETH, 1954, p. 206, fig. 49j (keyed only); STOCK, 1954, p. 139, fig. 69a–c.

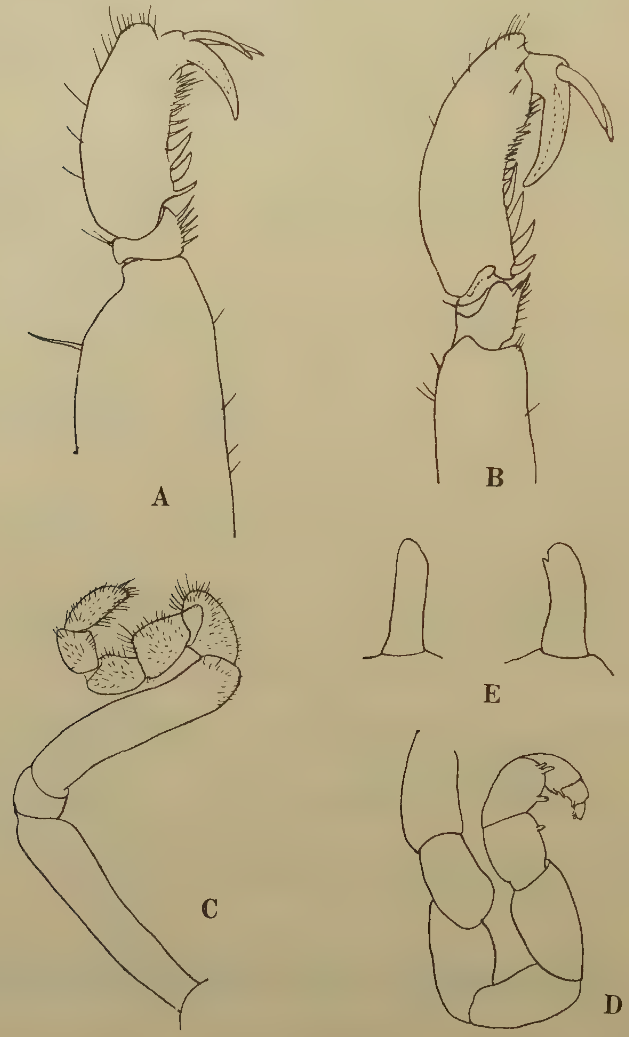

Fig. 5. *Lecythorhynchus hilgendorfi* (BÖHM).
A, distal joints of a female (Sp. No. 11); B, the same of a male (Sp. No. 33); D, oviger of a female (Sp. No. 11); E, simple oviger spines of a female.
(B–C ×33, A, D ×55, E ×510)

Material: 2 females (Sp. No. *Pycn.* 5c). 30 m south of Enosima. Depth unrecorded. 27–II–1938.

1 ovigerous male, 1 male and 4 females (Sp. No. *Pycn.* 20). Nazima, Hayama, shore. 20–VII–1952.

1 male (Sp. No. *Pycn.* 33). Mosaki, Kamegisyô, 7–8 fathoms. 22–VII–1957.

1 juvenile, lacking oviger (Sp. No. *Pycn.* 37). Mosaki, Kamegisyô, 7–8 fathoms. 22–VI–1957.

1 female (Sp. No. *Pycn.* 40). Kurosaki, shore. 29–VII–1958.

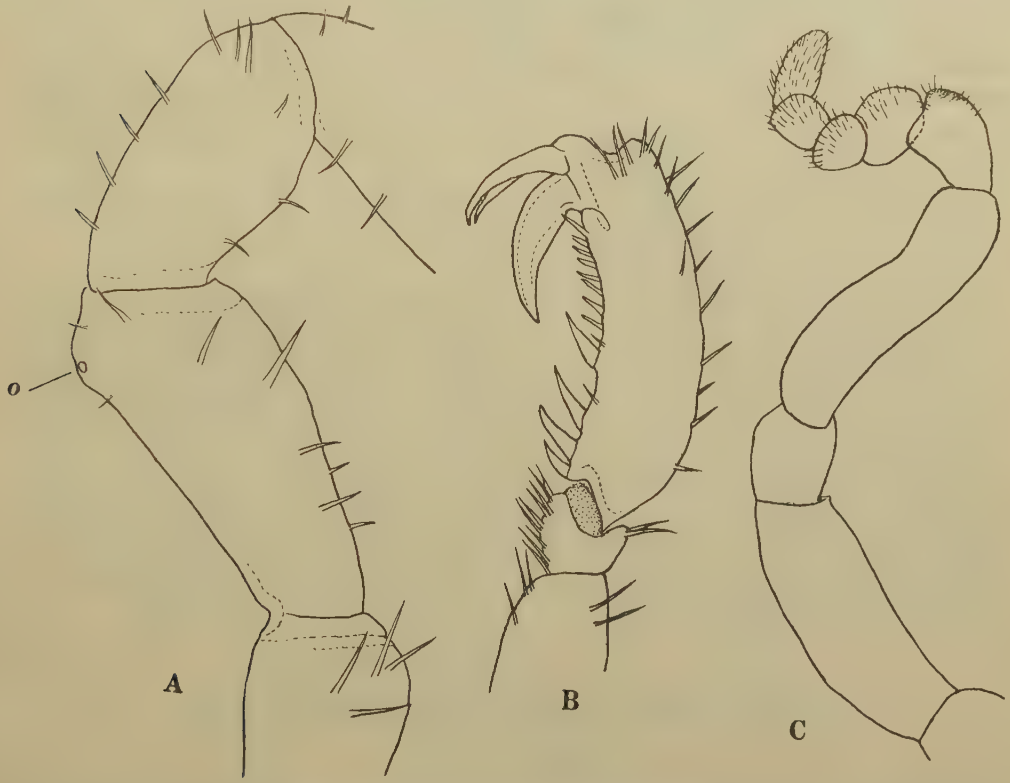

Fig. 6. *Lecythorhynchus hilgendorfi* (Böhm).
A, proximal joints of female leg, showing a genital opening (*o*); B, distal joints of male leg; C, palp of a female (Sp. No. 11). (C ×55, A–B ×67)

Remarks: This species is fairly well represented on the Japanese coasts and thus the material of all stages is plentifully available for comparison.

This species was originally described by Böhm (1879 a, c) from Enosima in Sagami Bay, and seems to be prevalent all along the coasts of Japan, ranging from Hokkaido to China. Afterwards, some of the authors such as Schimkewitsch, Losina-Losinsky, Helfer and Stock referred the specimens having the strongly inflated 5th joint in the palps to *L. marginatus* which was first recorded by Cole (1904) from the Californian coast (San Pedro Point and Dillon Beach), where it is very common according to American authors.

The principal differences between the two species, as enumerated by STOCK (1954, p. 140), seem to be not absolutely distinctive, largely depending upon the relative length as well as size in every joint of the appendages, so that it may be subject to individual variation. Certainly wrong drawings, when mounted on a slide at different levels, are largely due to the strong curvature of palps, thus these may mislead one especially concerning the exact shape of the 5th and succeeding joints of palps, which form together a flagellum as in other crustacean antennae. The same may be said for the arrangement and number of compound spines on the ovigers. Two figures of palps retouched after original sketching by means of the camera lucida are given here for comparison (Figs. 5C and 6C). As figured herein, the 5th joint of the palps is more or less inflated ventrally, variable in individuals, though not so well pronounced as in the next *hedgpethi* n. sp.

The genital opening is distinct on the ventral surface of the 2nd coxae of legs, situating on a slight protuberance near the distal end, but it is very minute (about 15μ in diameter) (cf. Fig. 6A, *o*).

As to the Hawaiian form *L. ovatus*, described by HILTON (1942b, 1943), I have no personal knowledge at present, but if HILTON's statement and figure are to be trusted, it may be a good species on account of the serrate appearance of the palps (according to HEDGPETH, however, that is illusory). Even if it is either distinct from *L. hilgendorfi* or not, at least COLE's *L. marginatus* seems to be synonymous with *L. hilgendorfi*. Indeed, according to HEDGPETH (1951, p. 111; 1954, p. 206), the Californian specimens also are marked in fresh material by conspicuous brownish purple bands on the legs (and trunk). To be sure, this littoral pycnogonid is widely distributed on both the coasts, east and west, in the northern Pacific, as in the case of *Ammothella bi-unguiculata* (DOHRN).

17. *Lecythorhynchus hedgpethi*, spec. nov.

(Figs. 7–9)

Material: 1 male (Sp. No. *Pycn.* 22—paratype). Warezima, 8 fathoms. 26–V–1952.

1 male (Sp. No. *Pycn.* 24—holotype). Off Hayama. Trawled. 1–II–1955.

1 male and 1 female, damaged (Sp. No. *Pycn.* 27—paratypes). Aoyama-dasi, Amadaiba, 80–90 m. 14–VI–1956.

1 male (Sp. No. *Pycn.* 32—paratype). Kannonzuka-dasi, Amadaiba, 80 m. 5–VI–1957.

1 male (Sp. No. *Pycn.* 41—paratype). Between Kannonzuka-dasi and Maruyama-dasi, 50 m. 19–XII–1958.

Description of Holotype: Body much larger than that of *L. hilgendorfi*, but not pigmented whatever. Trunk rather stout, distinctly segmented; sutures well-chitinized;

dorsum slightly ridged transversely in each segment in front of sutural lines. Cephalic segment slightly prolonged anteriorly, a little longer than wide in outline. Lateral processes a little longer than wide and separated by their own diameter. Ocular tubercle situated in the center of cephalic segment, erect, rather low, slightly pointed at tip, with 4 well-pigmented eyes. Abdomen comparatively long, elongate, projecting obliquely upwards. Surface minutely granular but not hairy.

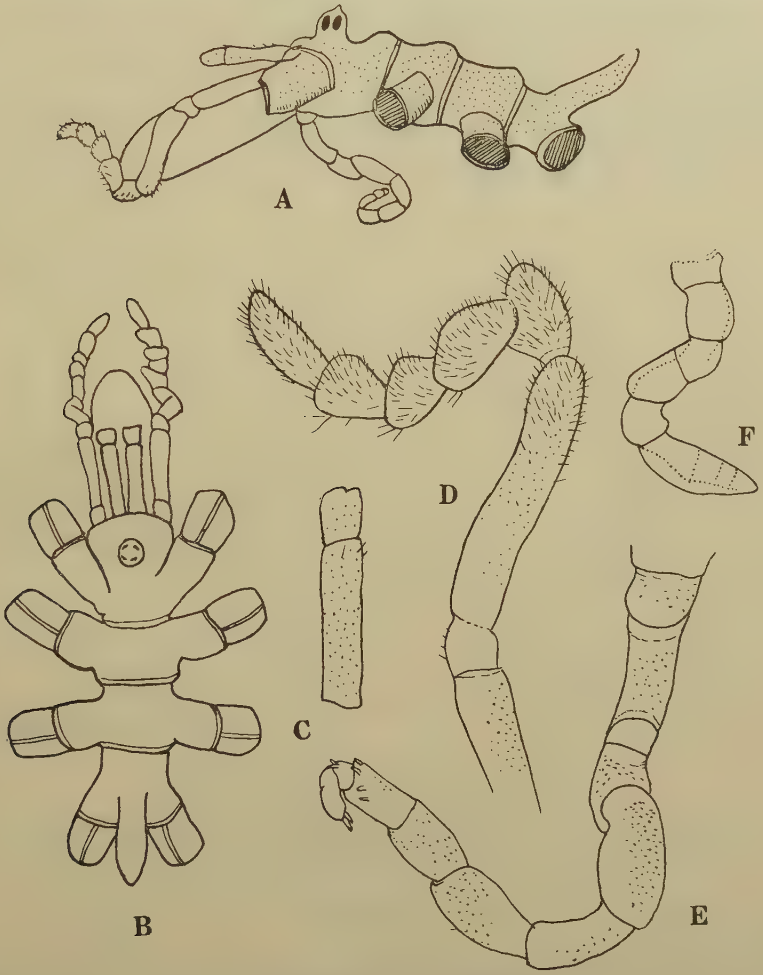

Fig. 7. *Lecythorhynchus hedgpethi*, n. sp.
A, male, paratype (Sp. No. 27), lateral view, legs omitted; B, the same, dorsal view; C, chelifore; D, palp; E, oviger of adult male (Sp. No. 27a); F, oviger of immature female (Sp. No. 27b).
(A–B ×13, C–F ×35)

Proboscis cylindrical, nearly as long as trunk, projecting obliquely downwards a little, somewhat tapering towards the base.

Chelifore elongate, distinctly 2-jointed, as long as cephalic segment and slightly less than half the length of proboscis. Scape slender, elongate; chela short and achelate; surface granular, almost unhairy.

Palpus very long, 9-jointed, sharply curved upwards at the 5th joint which is conspicuously produced distally; strongly setose in distal joints. The 6th joint is inserted at middle of the upper surface of the 5th joint. The terminal joint is elongate, somewhat flattened, a little longer and narrower than the penultimate joint.

Oviger 10-jointed, delicately granular and twisted in a complicated manner. Oviger spines, recalling those of the genus *Tanystylum*, are either simple or feebly denticulate and situated rather irregularly inside in the terminal 4 joints as in the following manner—2:3:4:3:4. These number may vary when simple setae or spinules are counted together.

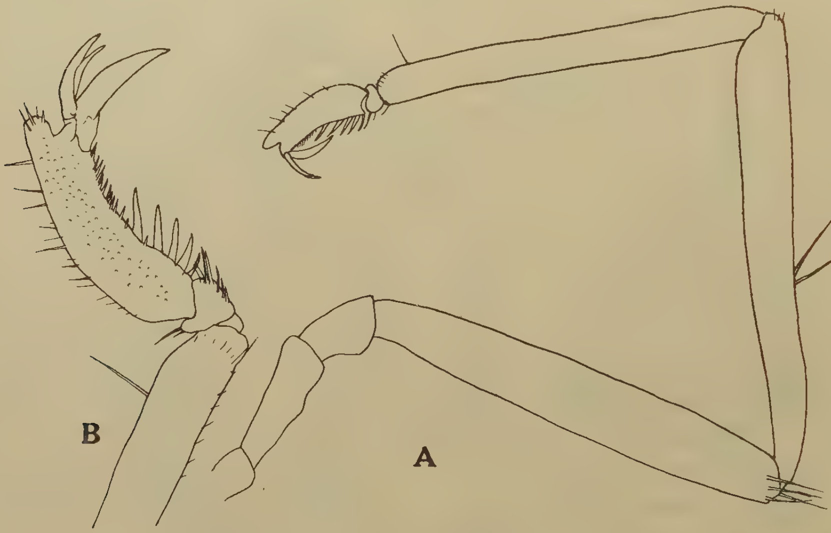

Fig. 8. *Lecythorhynchus hedgpethi*, n. sp.
A, fourth leg of a male, holotype (Sp. No. 24); B, distal joints of the same.
(A ×8, B ×25)

Legs considerably longer than in *L. hilgendorfi* and not pigmented whatever; they are somewhat over five times the length of the trunk, measuring about 20 mm in total length. All joints slender uniformly, smooth, though when examined in detail, feebly setose. Coxa 1 slightly longer than wide, coxa 2 about three times as long as wide with a slight swelling about midway on the dorsal surface and a slight swelling on the ventral surface distally, coxa 3 about half as long as coxa 2 but a little wider. Femur most plump of all joints and adorned with long setae dorso-distally. Tibia 1 rather plump but lesser than femur and scatteredly adorned with a few setae usually about midway. Tibia 2 longest of all joints, uniformly slender and adorned with a long seta near the distal end as in *L. hilgendorfi.* Tarsus shortest and armed with over 5 spines ventrally and with 1 or 2 spines dorsally. Propodus heavy, slightly curved, with a prominent distal process, armed ventrally with 5 basal spines and densely packed distal smaller spines and dorsally with many setae in a row, lateral surface strongly granular. Main claw strong, more than half the length of propodus; auxilliary claws rather strong, about 3/4 as long as main claw.

Remarks: This new species may possibly be identical with an unnamed species obtained once at the 'Albatross' Station 3730 (southwest of Omaé-zaki, 34–37 fathoms) which HEDGPETH (1949, p. 296, fig. 44e-f) hegitatingly referred to the genus *Lecythorhynchus* owing to the undeveloped appearance of the oviger and the uniquely 2-jointed chelate chelifores. However, the general conformation of the body and all appendages suggests its closest affinity with the genus *Lecythorhynchus*, as discussed above. Indeed, in the case of *L. hilgendorfi* too, according to LOU's detailed study on the postembryonal development, the chelifores are distinctly 2-jointed and chelate in larval stages, but later reduced to mere knobs in adults.

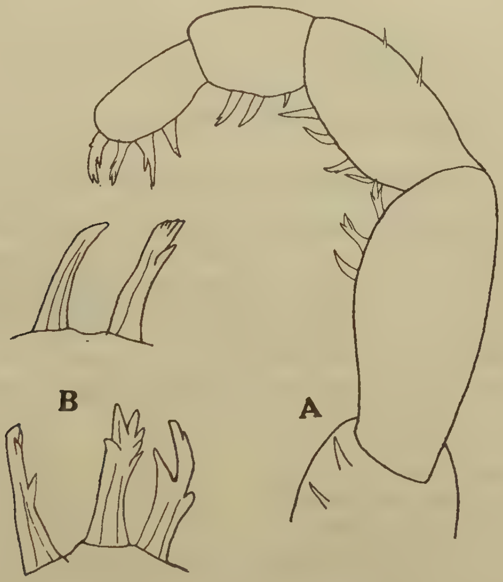

Fig. 9. *Lecythorhynchus hedgpethi* n. sp.
A, distal joints of male oviger; B, simple or less denticulate oviger spines.
(A ×75, B ×300)

Therefore, a new name for this unique species is now given after Dr. HEDGPETH who first noticed it. The habitat of this new species is apparently deeper bottoms instead of intertidal.

Measurements of a male (holotype) *in mm*:

Length of proboscis	2.5	Width of cephalic segment (at frontal edge)	1.0
Length of trunk	3.0	Width of trunk across 2nd seg. (incl. crurigers)	1.5
Length of abdomen	1.5	Height of ocular tubercle	0.5
Length of chelifore	1.0		
(scape	0.8)		

Fourth leg:

Coxa 1	0.59	Tarsus	0.3
Coxa 2	1.77	Propodus	1.77
Coxa 3	1.08	Main claw	0.83
Femur	6.20	Auxilliary claws	0.47
Tibia 1	6.50		
Tibia 2	7.97		

Family Pycnogonidae

Genus *Pycnogonum* Brunnich, 1764

18. *Pycnogonum tenue* Kishida

Pycnogonum littorale var. *tenue* Slater, 1879, p. 283; Ortmann, 1890, p. 167; Schimkewitsch, 1929, p. 15.

Pycnogonum tenue Kishida, 1927, p. 989, fig. 1905; Ohshima, 1936, p. 867 (listed only); Ohshima & Kishida. 1947, p. 1010, fig. 2865; Hedgpeth, 1949, p. 303, figs. 48b, 50c–d; Stock, 1954, p. 162, fig. 80; Utinomi, 1955, p. 36, fig. 22.

Material: 1 male (Sp. No. *Pycn.* 25). Koronbo, west of Amadaiba, 250–300 m. 16–VII–1955.

Measurements of a male in mm:

Length of proboscis	2.5
Length of trunk	4.5
Length of abdomen	2.0

Synopsis of Pycnogonids Hitherto Known from Sagami Bay and Its Surrounding Waters

Nymphonidae

**Nymphon grossipes* (O. Fabricius?) Krøyer

Utinomi, 1955, p. 4 (*Sôyô* St. 269, off Simoda).

**Nymphon japonicum* Ortmann

Ortmann, 1890, p. 158 (the material from Sagami Bay is, according to Stock, a separate species *N. ortmanni*): Loman, 1911, p. 8 (various localities in Sagami Bay, 150–350 m); Ohshima, 1936, p. 862 (? Minami Amadaiba, 260 fms. as *N.*

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* indicates the species contained in the collections of the His Majesty's Biological Laboratory and reported in this paper.

macrum WILSON); HEDGPETH, 1949, p. 249 (*Albatross* Sts. 3750, 3752, 3755, 3757, 41–140 fms.); STOCK, 1954, p. 18 (off Sunosaki, 20–80 fms.); UTINOMI, 1955, p. 5 (*Sôyô* Sts. 239, 255, 258, 259, 270, 279, 286, 123–432 m).

Nymphon ortmanni HELFER

HELFER, 1938, p. 164 (Sagami Bay, as noted above); STOCK, 1953a, p. 34 (Sagami Bay); STOCK, 1954, p. 20 (off Misaki, Okinose, 80–120 fms.).

Nymphon micropedes HEDGPETH

HEDGPETH, 1949, p. 254 (*Albatross* St. 5080, 505 fms.); OHSHIMA & KISHIDA, 1947, p. 1007 (Tokyo Bay & Sagami Bay, as *N. japonicum* ORTMANN).

Nymphon benthos HEDGPETH

HEDGPETH, 1949, p. 256 (*Albatross* St. 5085, 622 fms.).

Nymphon nipponense HEDGPETH

HEDGPETH, 1949, p. 267 (*Albatross* St. 4980, Tôtômi-nada, 507 fms.).

Callipallenidae

**Propallene longiceps* (BÖHM)

BÖHM, 1879b, p. 59 (Enosima, as *Pallene longiceps*); Ortmann, 1890, p. 165 (Kadsiyama=Katuyama, as *Pallene longiceps*); FUKUI, 1918, p. 97 (Kamakura, as *Pallene longiceps*); OHSHIMA, 1933a, p. 96, 1933c, p. 212 (Misaki, as *Pallene longiceps*); STOCK, 1954, p. 31 (Misaki, 3 fms.).

Pallenopsis mollissima (HOEK)

HOEK, 1881, p. 87 (*Challenger* St. 237, off Bôsyû, 1875 fms., as *Phoxichilidium mollissimum*); HEDGPETH, 1949, p. 277 (*Albatross* St. 5080, SW of Sagami Bay, 505 fms.).

**Pallenopsis virgata* LOMAN

HEDGPETH, 1949, p. 277 (*Albatross* St. 3730, SW of Omaé-zaki, 34–37 fms.).

Pallenopsis sibogae LOMAN

UTINOMI, 1955, p. 19 (*Sôyô* St. 278, Suruga Bay, 79 m).

Pallenopsis spec.

LOMAN, 1911, p. 13 (Sagami Bay, as *Pallenopsis* n. sp. ? which is acc. to SCHIMKEWITSCH (1930, p. 237) probably *P. hoekiana* SCHIMKEWITSCH).

Phoxichilidiidae

Phoxichilidium ungellatum HEDGPETH

HEDGPETH, 1949, p. 281 (*Albatross* Sts. 5079, 5080, SW of Omaé-zaki, 475–505 fms.); STOCK, 1954, p. 71 (Okinose, 100 fms.).

Anoplodactylus gestiens (ORTMANN)

ORTMANN, 1890, p. 166 (Kadsiyama=Katuyama, 70–200 fms., as *Phoxichilidium gestiens*); LOMAN, 1911, p. 13 (Sagami Bay, 150–180 m); HEDGPETH, 1949, p. 284 (*Albatross* Sts. 3703, 3715, 3739, Suruga Bay, 31–68 fms.); STOCK, 1954, p. 71 (off Misaki, Okinose, 80–120 fms.).

Anoplodactylus mamillosus STOCK

STOCK, 1954, p. 72 (Sagami Bay, 300-400 fms.).

Anoplodactylus pycnosoma (HELFER)

STOCK, 1953a, p. 41, 1954, p. 75 (Misaki, beneath low tide).

**Anoplodactylus versluysi* LOMAN

Not ever recorded from Japan (incl. Sagami Bay).

Anoplodactylus spec.

HEDGPETH, 1949, p. 284 (*Albatross* Sts. 5075, 5078, Tôtômi-nada, 22-514 fms.).

Anoplodactylus spec.

STOCK, 1954, p. 88 (Misaki, beneath low tide).

Ammotheidae

Achelia japonica UTINOMI

ORTMANN, 1890, p. 164 (Kadsiyama=Katuyama, shallow water, as *Achelia echinata* var. *japonica*); UTINOMI, 1954, p. 14 (renamed only).

**Achelia superba* (LOMAN)

LOMAN, 1911, p. 11 (Sagami Bay, 80-180 m, as *Ammothea superba*); STOCK, 1954, p. 96 (Misaki, about 20 fms.); UTINOMI, 1955, p. 23 (*Sôyô* St. 376, SW of Omaé-zaki, 64 m).

**Achelia echinata* HODGE

FUKUI, 1918, p. 97 (Hôzyô, ? as *Achelia* sp.); STOCK, 1956, p. 98 (off Misaki, 200 fms., as *A. echinata* ssp. *nasuta*).

Achelia bituberculata HEDGPETH

HEDGPETH, 1949, p. 287 (Misaki); STOCK, 1954, p. 94 (Misaki, coast).

Achelia spinosa (STIMPSON)

STOCK, 1954, p. 96 (Sagami Sea, 400 fms.).

Achelia spec. (?) 〔larva〕

OHSHIMA, 1933a, p. 94, 1933c, p. 61 & p. 65 (Hôzyô, as *Ammothea* (?) sp. attached to a nudibranch *Armina variolosa* BERGH).

Ammothella profunda HEDGPETH

HEDGPETH, 1949, p. 289 (*Albatross* St. 5083, Tôtômi-nada, 624 fms.).

**Ammothella indica* STOCK

Not ever recorded from Japan (including Sagami Bay).

**Nymphopsis muscosa* LOMAN

LOMAN, 1911, p. 11 (off Misaki 50 m, Zusi 130 m).

**Cilunculus armatus* (BÖHM)

BÖHM, 1879c, p. 141 (Enosima, as *Lecythorhynchus armatus*); ORTMANN, 1890, p. 163 (Kadsiyama=Katuyama, as *Parazetes pubescens*); LOMAN, 1911, p. 9 (off Enosima, Misaki & Zusi, 80-131 m); HEDGPETH, 1949, p. 274 (*Albatross* St. 3734, SW of Omaé-zaki, 36-48 fms.); UTINOMI, 1955, p. 28 (*Sôyô* St. 236, off Sunosaki, Sagami Bay, 251 m).

Scipiolus spinosus Utinomi

Utinomi, 1955, p. 31 (*Sôyô* St. 284, Senoumi, Suruga Bay, 71 m).

Scipiolus validus Stock

Stock, 1957 a, p. 91 (Uraga Canal, 21 fms.).

**Ascorhynchus auchenicum* (Slater)

Ortmann, 1890, p. 162 (Tokyo Bay & Sagami Bay, 100 fms., as *Ascorhynchus bicornis*) ; Loman, 1911, p. 6 (off Misaki 50 80 m, off Enosima 80 m, as *As. ramipes* (part) ; Fukui, 1918, p. 97 (Hôzyô, as *Ascorhynchus* sp.) ; Schimkewitsch, 1929, p. 111 (Misaki, as *As. minutus* Hoek) ; Hedgpeth, 1949, p. 291 (*Albatross* St. 3707, off Osezaki, Suruga Bay, 60–70 fms.) ; Stock, 1954, p. 124 (off Misaki, 3–300 fms.).

**Ascorhynchus ramipes* (Böhm)

Böhm, 1879 b, p. 56 (Enosima, as *Gnamptorhynchus ramipes*) ; Ortmann, 1890, p. 161 (Sagami Bay, 50–100 fms.) ; Loman, 1911, p. 5 (Sagami Bay, 50–80 m (part) ; Hedgpeth, 1949, p. 292 (Tokyo Bay).

**Ascorhynchus japonicum* Ives

Ives, 1892, p. 219 (Loc. undefined, shallow sea) ; Loman, 1911, p. 5 (Odawara, Hukuura) ; Ohshima, 1936, p. 865 (Amadaiba, 150–260 fms, 350–500 m ; off Kurosaki, 150 fms.) ; Hedgpeth, 1949, p. 292 (*Albatross* Sts. 4980, 5079, 5082 & 5084, Tôtômi-nada ; *Albatross* St. 5094, Sagami Bay, 88–507 fms.) ; Stock, 1954, p. 126 (off Misaki, 80–120 fms.).

Ascorhynchus cryptopygium (Ortmann)

Ortmann, 1890, p. 159 (Sagami Bay, 60–150 fms) ; Loman, 1911, p. 7 (Uraga Canal) ; Stock, 1954, p. 121 (Sagami Bay, 80–120 fms.) ; Utinomi, 1955, p. 24 (*Sôyô* St. 236, off Sunosaki, 251 m).

Ascorhynchus glabroides Ortmann

Loman, 1911, p. 7 (Sagami Bay).

**Ascorhynchus glaberrimum* Schimkewitsch

Not ever recorded from Sagami Bay.

**Lecythorhynchus hilgendorfi* (Böhm)

Böhm, 1879 a, p. 187 (Enosima, 3–4 fms., as *Corniger hilgendorfi*) ; Böhm, 1879 c, p. 140 (Enosima, renamed as above) ; Loman, 1911, p. 8 (Enosima, redescribed Böhm's type) ; Ohshima, 1933 a, p. 95 (Tateyama Bay) ; Hedgpeth, 1949, p. 296 (near Chochi = Chôshi or Tyôsi, northeast cape of Bôsô Peninsula) ; Stock, 1954, p. 139 (Misaki, shore, as *L. marginatus*).

**Lecythorhynchus hedgpethi* Utinomi (n. sp.)

Hedgpeth, 1949, p. 296 (*Albatross* St. 3730, SW of Omaé-zaki, Tôtômi-nada, 34–37 fms., as ? *L.* spec.).

Tanystylum scrutator Stock

Stock, 1954, p. 142 (Misaki, shore).

Austrodecidae

Austrodecus tubiferum STOCK
STOCK, 1954, p. 153 (Okinose, 100 fms., as *A. gordonae* (part)) ; STOCK, 1957 b, p. 75 (Okinose, renamed as above).

Colossendeidae

Colossendeis japonica HOEK
HOEK, 1898, p. 295 (*Challenger* St. 237, off Bôsô Peninsula, 1875 fms.).

Colossendeis colossea WILSON
LOMAN, 1911, p. 4 (Sagami Bay, as *C. gigas* HOEK) ; HEDGPETH, 1949, p. 299 (*Albatross* St. 5082, Tôtômi-nada, 662 fms.).

Colossendeis macerrima WILSON
LOMAN, 1911, p. 4 (Okinose Bank, 1400 m, as *C. leptorhynchus* HOEK) ; HEDGPETH, 1949, p. 299 (*Albatross* St. 5083, Tôtômi-nada, 624 fms.).

Colossendeis dofleini LOMAN
LOMAN, 1911, p. 4 (near Misaki) ; HEDGPETH, 1949, p. 300 (*Albatross* St. 5079, Tôtômi-nada, 475–505 fms.).

Colossendeis chitinosa HILTON
HEDGPETH, 1949, p. 301 (*Albatross* St. 3703, Senoumi, Suruga Bay, 31 fms. & Sagami Bay).

Pycnogonidae

**Pycynogonum tenue* KISHIDA
ORTMANN, 1890, p. 167 (Sagami Bay, 100 fms., as *P. litorale* var. *tenue* SLATER) ; KISHIDA, 1927, p. 989 (Locality not given) ; HEDGPETH, 1949, p. 303 (*Albatross* Sts. 3707, 3708, 3716 ; Osezaki, Suruga Bay, 60–125 m).

Pycnogonum ungellatum LOMAN
LOMAN, 1911, p. 7 (Sagami Bay).

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CONTRIBUTIONS TO JAPANESE ASCIDIAN FAUNA

XIII. SPORADIC MEMORANDA (4)[1]

Takasi TOKIOKA
Seto Marine Biological Laboratory, Sirahama

With Plates XIII–XVIII and 1 Text-figure

In this paper are presented the results of the examination on two materials of ascidians. One is a small collection made by Mr. E. Harada of our laboratory on Nov. 28, 1957 on a trawler working in the area about 20 km off Tanabe Bay and the other is a bigger one collected by Mr. S. Kobayasi of the Hukui Local Museum of Natural History in 1954–1958 along the coast of Wakasa Bay situated approximately at the middle of the Japan Sea side of the main island of Japan or on trawlers of Kuriya Base working chiefly in Wakasa Bay.

I. Material dredged off Tanabe Bay

This comprises two kinds of pyrosomas and two compound ascidians, of which one form belonging to the genus *Homoeodistoma* seems to represent a new species.

1) *Pyrosoma atlanticum atlanticum* Péron, 1804. The largest colony is 97 mm long, 26 mm wide and 10 mm thick; and faintly pinkish in colour. The surface is wholly covered with conspicuous spiny protuberances.

2) *Pyrosoma spinosum* Herdman, 1888. Elongate, 165 mm in length and 16 mm in diameter. The test is quite transparent and very fragile; the surface is provided sparsely with spiny protuberances. Zooids reddish.

3) *Syndiazona grandis* Oka. Two olive brown and roundish gelatinous colonies, respectively 30 mm in diameter and 24 mm high and 29 mm in diameter and 27 mm high; both being devoid of peduncular portion. The test is soft and translucent, the yellowish zooids being seen through. Zooids up to 11 mm, of which 4 mm is occupied by thorax; the stomach is smoothly surfaced and situated in the posterior 3–4 mm of the abdomen. Stigmatal rows about 25; about 15 transverse muscles on each side of thorax, of which several anterior ones are slightly oblique. Gonad immature. These specimens are apparently young colonies of *Syndiazona grandis*.

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4) *Homoeodistoma longigona* n. sp.

(Pl. XIII, figs. 1-5)

A single colony was dredged from the sandy bottom about 120 m deep and about 23 km off Sirahama. Examining the colony closely, it was found that the specimen represents a new member of the genus *Homoeodistoma* hitherto known in the Japanese waters by only a single species *H. michaelseni* REDIKORZEV from the Okhotsk Sea. The colony is a mass measuring 33 mm in length and 17 mm in diameter and consists of three cormidia which are less than 12 mm in diameter on the elliptical coronal surface and very shortly pedunculated. Only the coronal portions of cormidia are projected out of the surface of the colonial mass which is hard gelatinous in consistency, but whitish and translucent allowing to see zooids faintly through the test. The test is rather soft on the upper surface of corona; the basal portion of colony is yellowish brown in colour and covered with fine sand grains and shell fragments.

Zooids: Zooids are 15-20 mm in length. Both branchial and atrial apertures open directly to the exterior. The abdomen is about two-thirds as long as the thorax. The postabdomen is very slender, attaining to four times the length (3-4 mm) of thorax and abdomen measured together.

Thorax: Both apertures 6-lobed. The branchial aperture is usually withdrawn to the level posterior to the atrial by contraction of thoracic muscles. There are 6 orange ocelli around the atrial aperture, and the basal portion of the branchial aperture is encircled on each side by a very distinct yellowish pigment band along the peripharyngeal band, besides a small pigment spot of the same colour is found at the ventral base of the dorsal ganglion. Fifteen to seventeen thoracic muscles on each side; they are roughly running obliquely, starting from the ventral side and converging to the branchial aperture; several posterior muscles are rather delicate. About twenty stigmatal rows are present; the number of stigmata in each row is obscured by contraction. Tentacles ca. 8. The anus is bilobed, and there are about six stigmatal rows in front of the level where the anus is attached.

Abdomen: Oesophagus short. The pyloric end of the stomach is located at the middle of the abdomen. The stomach wall is smooth, except for the distinct mark made by a very stout typhlosole. The hind-stomach and the mid-intestine are separated from each other by a slight constriction. The proximal end of the rectum is strongly constricted from the foregoing part, but no coecum is formed there.

Postabdomen: The vas deferens is very long reaching posteriorly near the rear end of the postabdomen and very thick being fully filled with sperms. Many eggs (25 in an examined zooid) are arranged along the whole dorsal side of the vas deferens; they seem all to be enveloped in the fertillization membrane. Thus it is possible that the dorsal half of the postabdomen is a long ovary and at the same time it works as a long incubatory pouch as PÉRÈS describes such a structure in *Pseudodistoma cyrnusense.*

Remarks: (1) Both branchial and atrial apertures opening directly to the exterior, (2) the existence of postabdomen, (3) the stomach smoothly surfaced, and (4) the ovary and testis being arranged side by side in the postabdomen, these four points are the characteristics assigning the present form to the genus *Homoeodistoma* REDIKORZEV 1927. *H. michaelseni* REDIKORZEV from the Okhotsk Sea and the coasts along Kamtchatka Peninsula resembles the present form in the appearance of the colony. In the former, however, the stigmatal rows are much fewer (12) than in the latter and the postabdomen is much shorter, being only slightly longer than the abdomen. For these reasons, the present form is treated here as a new species and named "*longigona*" after its long postabdmen containing long gonads running throughout it.

II. Material from Wakasa Bay

Besides twenty-one species of ascidians, two pyrosomas from other locality are included in the collection of the Hukui Museum. They are:

1. *Didemnum (Didemnum) moseleyi* (HERDMAN)
2. *Ciona intestinalis* (LINNAEUS)
3. *Ascidia zara* OKA
4. *Ascidia sydneiensis samea* (OKA)
5. *Botrylloides violaceum* OKA
6. *Symplegma reptans* (OKA)
7. *Polycarpa granosa* TOKIOKA
8. *Polycarpa maculata* (HARTMEYER)
9. *Polycarpa cryptocarpa* var. *kroboja* (OKA)
10. *Cnemidocarpa areolata* (HELLER)
11. *Cnemidocarpa fertilis* f. *minor* TOKIOKA
12. *Cnemidocarpa macrogastra* (OKA)
13. *Styela esther* HARTMEYER
14. *Styela clava* HERDMAN
15. *Pyura lepidoderma* TOKIOKA
16. *Pyura mirabilis* (v. DRASCHE)
17. *Herdmania momus* (SAVIGNY)
18. *Boltenia echinata* (LINNAEUS)
19. *Halocynthia hilgendorfi* (TRAUSTEDT)
20. *Microcosmus hartmeyeri* OKA
21. *Microcosmus multitentaculatus* TOKIOKA

PYROSOMATA

1. *Pyrosoma atlanticum atlanticum* PÉRON
2. *Pyrosoma operculatum* NEUMANN

No new species is presented in this material. Of these species, however, *Polycarpa granosa* and *Cnemidocarpa fertilis* f. *minor* are described respectively merely on a single specimen and *Polycarpa maculata* and *Microcosmus multitentaculatus* are reported only twice by this day. So the descriptions on specimens of these species found in the present material seem to be very useful for ascertaining their validity. Moreover, as the ascidian fauna in the Japan Sea has been known only a

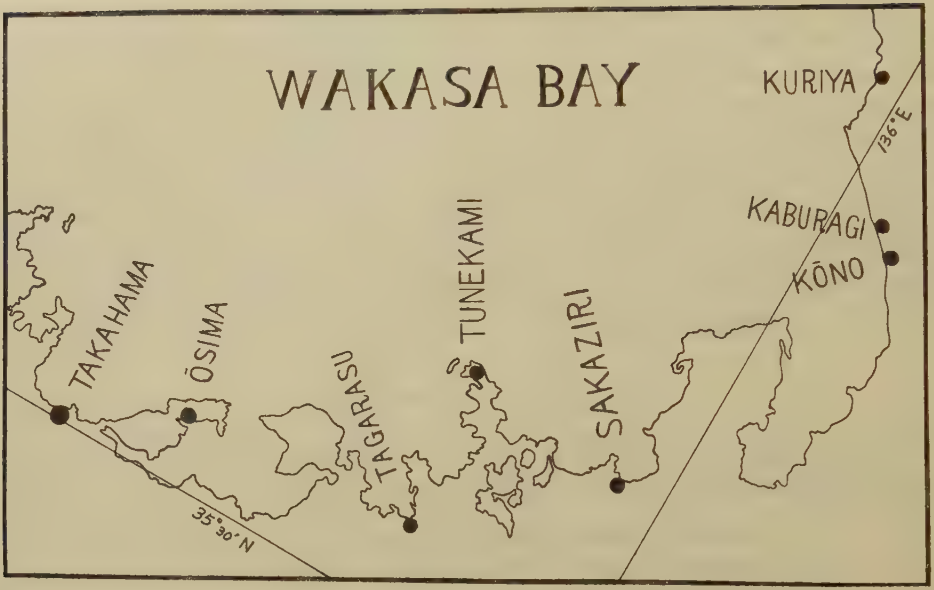


Fig. 1. Map showing localities along the coast of Wakasa Bay, where the present material was collected.

little, it seems to be significant to give here exact localities and some morphological notes for each species in a hope that those might be useful for the affirmation of regional variations found in some species.

1) *Didemnum* (*Didemnum*) *moseleyi* (HERDMAN). Four small white colonies, up to 10 mm×5 mm in extent, found on the test of *Microcosmus hartmeyeri* collected by a trawler of Kuriya Base. They are very thin, ca. 0.5 mm in thickness. Calcareous spicules are distributed densely throughout the colony and rather large, most frequently 30-40μ in diameter, though fluctuating between 28μ and 52μ in examined pieces ; the number of rays on the equatoriai plane vary from 10 to 12.

2) *Ciona intestinalis* (LINNAEUS). Seven individuals from Sakaziri, collected on Aug. 8, 1958.

3) *Ascidia zara* OKA (Pl. XIV, fig. 6). A small 8 mm long (in mantle body) specimen found attached on the 90 mm long *Polycarpa cryptocarpa* var. *kroboja* collected by a trawler of Kuriya Base. The test is gelatinous, transparent and armed with a number of spinule-like protuberances over the surface. The musculature on the right side of the mantle body consists chiefly of transverse muscle bands. The branchial aperture 8-lobed and the atrial 6-lobed. The anterior end of the intestinal loop reaches far beyond the base of the atrial siphon. A small amount of mature eggs found in the oviduct.

4) *Ascidia sydneiensis samea* OKA (Pl. XIV, figs. 7-8). A single 29 mm long specimen from Tagarasu, collected on Aug. 11, 1957. The body is elliptical and

attached to the substratum by the whole left side. The test is soft cartilaginous, translucent and faintly grayish purple in colour; the peripheral portion is provided with a number of finger-shaped protuberances up to 3.5 mm in length and bifid at the tip in some ones, while the central area is slightly depressed and nearly smooth. The branchial siphon terminal and the atrial situated approximately at the middle of the dorsal side of the body; the former has 7- and the latter with 6-ridges on the surface, each ridge carries a few spiny protuberances. The mantle musculature reddish brown, widely interrupted. The ciliated groove simply U-shaped. The anterior end of the intestinal loop does not extend beyond the anterior base of the atrial siphon. Apparently this is a young individual of a spinose form of *A. sydneiensis samea.*

5) *Botrylloides violaceum* OKA. Four colonies encrusting sargassums and other objects. Zooids are brownish violet in two colonies, while they are nearly pigmentless in other two. Stigmatal rows 8-11, stomach with 8 longitudinal plications besides typhlosole. Loc.: Three colonies from Sakaziri, collected on Aug. 8, 1958 and one colony from Kôno, collected on Aug. 1, 1957.

6) *Symplegma reptans* (OKA). Two colonies encrusting sargassums, collected at Takahama on Aug. 13, 1955. About eight stigmatal rows are present. The anterior end of the intestinal loop reaches the middle of the fourth stigmatal row. The pyloric coecum is very prominent and issues from its distal end a vessel which bridges between the coecum and the rectum.

7) *Polycarpa granosa* TOKIOKA, 1953

(Pl. XIV, figs. 9-14)

A single specimen found in the trawled material examined at Kuriya. The animal is 72 mm long and 39 mm high, but only 15 mm wide, being strongly depressed laterally. The whole body is covered densely with gravels; both apertures are sessile and quite invisible from the surface. The test itself is rather thin, soft and transparent, but it holds many fine sand grains within it, besides coarse ones. The mantle is very thin and delicate. The branchial aperture terminal and the atrial is situated at one-third of the body length from the posterior end of the body; both siphons are very short and coloured reddish-brown near their bases. Atrial tentacles are long, but very thin. No endocarps are found on the inner surface of the mantle.

Branchial sac: Four folds on each side. The inner longitudinal vessels are arranged in the middle portion as follows:

Right D 7 (16) 10 (20) 9 (17) 8 (17) 9 V
Left D 7 (16) 9 (21) 9 (21) 8 (14) 7 V

Transverse vessels are arranged in the order of 1 3 2 3 1 or 1 2 1, where numerals indicate the order of thickness. Parastigmatic vessels absent. Six to eight stigmata in a mesh in intermediate areas. Tentacles 36, larger and smaller ones alternate rather regularly, being intervened by minute one at each interval. The ciliated groove is simply U-shaped.

Alimentary system: The intestinal loop is confined to the posterior half of the body and very wide. The second loop is extremely shallow, with the axis passing through near the middle of the ventral branch of the loop excluding the stomach. The stomach is elongate and occupies nearly one-third of the whole ventral branch of the loop; there are several longitudinal plications on each surface, but no pyloric coecum is seen. The anal margin is cut into 13 lobules. The oesophagus is very short. A number of minute endocarps are found on the intestinal wall.

Gonad: Eighty one gonads on the left and 132 on the right side. They are elongate elliptical in shape, up to 3.5 mm in length, and attached to the inner surface of the mantle by only a small part of the capsule surface. Testicular follicles are arranged roughly in two rows on the attachment side.

Remarks: Some slight differences are found in features of various organs between the present specimen and the type specimen from Sagami Bay. In the type specimen, the alimentary organ occupies wider area than in the present specimen and a pad-like structure is found in front of the dorsal tubercle. The most striking difference is, however, the existence of an accessory fold at each of the second to fourth branchial folds in the type specimen. The numbers of inner longitudinal vessels on the second to fourth branchial folds in the type specimen agree well with those in the present specimen, if the vessels on both proper and accessory folds are counted together in the type specimen. Probably all these above-mentioned differences are attributable to the degree of contraction or to some environmental conditions, but insignificant as characteristics differentiating these two specimens from each other. And, at present, it is quite impossible to decide definitely which of the type and present specimens represents the regular feature of *P. granosa*.

8) *Polycarpa maculata* (HARTMEYER), 1906

(Pl. XV, figs. 15–20)

A 30 mm long oval individual was dredged by a trawler of Kuriya Base. The posterior half of the body is encrusted with coarse and fine sand grains, while the distal half is nearly exposed, wrinkled irregularly and carries some hydrozoan colonies on the surface. The branchial aperture is terminal and the atrial is situated approximately at one-third of the body length from the anterior end of the body; both apertures are sessile and hardly visible from the surface. The test is soft cartilaginous, translucent and yellowish brown in colour and up to 2 mm in thickness. The mantle is of a moderate thickness, dark brownish in colour and devoid of endocarps on the inner surface. Fine tentacles are found set densely along the margin of the atrial velum.

Branchial sac: Inner longitudinal vessels are arranged as follows:

Right D 0 (14) 2 (13) 2 (13) 2 (9) 1 V
Left D 0 (10) 3 (13) 2 (14) 2 (11) 2 V

Transverse vessels are arranged in the following order: 1 4 3 4 2 4 3 4 1, where the numerals represent the order of thickness. Parastigmatic vessels absent. Ten to twelve stigmata in a mesh in intermediate areas. Tentacles 45 including both large and small ones, but excluding a small number of minute ones. The ciliated groove S-shaped.

Alimentary system: The intestinal loop is rather narrow; the second loop is very shallow, with the axis passing through near the middle of the stomach which is elongate and with seven longitudinal plications on the free surface and a small pyloric coecum. The oesophagus short, the rectum is long and the anus is surrounded with six lobules on one side and with three on the other side. All these organs are also coloured dark brownish as the mantle is. A large endocarp is present in the first intestinal loop.

Gonad: Twenty-six gonads on the right and 21 on the left side. They are elliptical in shape, up to 3 mm in length, and attached to the inner surface of the mantle by only a small part near the proximal portion. Many testicular follicles arranged on the attachment side.

Remarks: This is the third record of the species in the Japanese waters.

9) *Polycarpa cryptocarpa* var. *kroboja* (OKA) (Pl. XV, figs. 21–22). Two individuals found in the material dredged by a trawler of Kuriya Base. They are respectively 70 mm and 90 mm in length, the former is heavily infested by two kinds of parasitic copepods in the mantle and branchial sac, and the latter carries many small simple ascidians and hydrozoan colonies on the test surface and also infested by parasitic copepods in the branchial sac. A pontiniid shrimp was found in each specimen. The ciliated groove is simple in both specimens. Four branchial folds on the left and five on the right side; the first (dorsal-most) rudimentary fold on the right side is formed only in the posterior half of the sac. The inner longitudinal vessels are arranged as follows in the 70 mm long individual:

Right D 0 (7) 2 (10) 6 (17) 5 (15) 4 (18) 3 V
Left D 4 (12) 7 (16) 6 (16) 6 (13) 6 V

Eighteen tentacles are found in the 70 mm long individual, larger and smaller ones are differentiated. Both specimens are immature.

Remarks: This is the first record of the occurrence of this species in the Sea of Japan.

10) *Cnemidocarpa areolata* (HELLER) (Pl. XV, figs. 23–24). Three specimens collected by a trawler of Kuriya Base. They are respectively 29, 36 and 47 mm in length and all fully mature. The external appearance resembles very closely that of *Styela plicata* (LES.) and the basal portion is encrusted with gravels. Some gonads may be divided into three branches in the proximal half as is shown in fig. 23.

Besides the above-mentioned specimen, a minute 2.5 mm long specimen was found on the surface of a specimen of *Polycarpa cryptocarpa* var. *kroboja*. It is roughly spherical in shape, with both siphons situated on the dorsal side. The test thin, leathery and pale yellowish brown in colour, being tinted red on siphons and around their bases. The mantle is thin and pale pinkish brown in colour. Distinct endocarps are found on the inner surface of the mantle. There are only three branchial folds on each side, of which the third (ventral-most) one is lower than others. Tentacles ca. 15, larger and smaller ones alternate regularly, the cilliated groove is an elongate oval slit. Eight plications are found on the free surface of the oval stomach which occupies the most part of the ventral branch of the intestinal loop. The axis of the second loop passes through the oesophageal region. The anus 6-lobed. No trace of gonads can be seen. It is very difficult to identify exactly this very young immature specimen, but the existence of a number of endocarps, the situation of the second intestinal loop with the axis passing through the oesophageal region and the oval stomach occupying the larger part of the ventral branch of the intestinal loop seem to allude the possibility that this specimen might belong to *Cn. areolata*.

11) *Cnemidocarpa fertilis* f. *minor* TOKIOKA, 1954

(Pl. XVI, figs. 26-29)

Two specimens found attached to a large specimen of "*ritteri*"- form of *Halocynthia hilgendorfi* dredged in Wakasa Bay. They are oval in outline, respectively 8 and 10 mm in length and attached by the ventral side, where the test is very thin. On the dorsal side, the test is leathery, marked with irregular grooves and furrows and dark purplish in colour. The inner surface of the test is bright purplish on the dorsal side. Both apertures are 4-lobed and sessile. The mantle is of a moderate thickness, especially thicker and sprinkled with greenish yellow pigment flecks on the dorsal side. A few endocarps are seen on the inner surface. Atrial tentacles are very fine.

Branchial sac: The inner longitudinal vessels are arranged as follows:

Right D 0 (11) 1 (8) 1 (11) 1 (7) 1 V
Left D 1 (11) 1 (9) 2 (9) 1 (7) 1 V

Transverse and parastigmatic vessels alternate regularly. Up to eight stigmata in a mesh. Tentacles ca. 15 including larger and smaller ones, alternating regularly and being intervened by minute ones at intervals. The ciliated groove is simply U-shaped. Tentacles and some vessels of the branchial sac are partly filled with yellowish corpuscles.

Alimentary system: The stomach is small, elliptical in outline and marked with nine longitudinal plications on the free surface. The second intestinal loop is very deep, its axis is passing through the middle of the ventral branch of the intestinal loop. The free margin of the anus is cut into four lobules. In the 10 mm long individual, three gonads on the left and four on the right side.

Remarks: This is the second record of the species and thus the occurrence is significant to ascertain the existence of such a minor form in *Cn. fertilis.* It is, however, very difficult, at present, to judge whether the present form represents merely an ecological form of *Cn. fertilis* or it is deserved to be ranked as a variety.

12) *Cnemidocarpa macrogastra* (OKA) (Pl. XVI, fig. 25). Two specimens, respectively 15 mm and 26 mm in length, dredged in Wakasa Bay and other two, respectively 21 mm and 26 mm long, collected at Kuriya on Feb. 15, 1958. Dredged specimens are attached to gravels and their shape is rather irregular; the larger specimen is contracted so strongly that the test is irregularly wrinkled and grooved and shows somewhat a dark yellowish leathery appearance. The stomach occupies one half of the ventral branch of the intestinal loop and the axis of the second intestinal loop passes through the middle of the stomach in the above-mentioned specimen. Contrarily, specimens from Kuriya are rather spherical in shape and nearly smoothly surfaced. The test is pale yellowish brown or pale pinkish brown with a greenish tint at some parts of the surface. In the larger specimen, the intestinal loop is rather small as shown in fig. 25. The stomach has a minute pyloric coecum, the anal margin is cut into 17 lobules. Six gonads on each side. The arrangement of the inner longitudinal vessels of the branchial sac is as follows:

Right D 5 (30) 9 (28) 8 (27) 11 (21) 8 V
Left D 5 (33) 10 (27) 8 (24) 10 (18) 7 V

Probably this specimen represents a short-side extremity of the variation found in the length of the intestinal loop.

13) *Styela esther* HARTMEYER (Pl. XVI, figs. 30–31). A 27 mm long individual from Tunegami, collected on Aug. 5, 1954. The animal seems to be attached on gravels. About ten longitudinal plications on the free surface of the oval stomach and the anal margin is nearly plain except for a few slight incisions. The ciliated groove is U-shaped.

14) *Styela clava* HERDMAN. A single specimen collected at Kuriya in June 1958. The body proper is 30 mm and the peduncle attains to 35 mm in length. Two gonads on the left and four on the right side, where the gonads are arranged in two pairs.

15) *Pyura lepidoderma* TOKIOKA. Two 22 mm long individuals from Kuriya, collected on July 28, 1957, two mature specimens attached to the surface of a "*ritteri*"-form of *Halocynthia hilgendorfi*; eleven small, less than 6.5 mm long, specimens found on the surface of the 90 mm long specimen of *Polycarpa cryptocarpa* var. *kroboja*, and a single 8 mm long specimen attached to the surface of a specimen of *Microcosmus hartmeyeri*. The 22 mm long specimens are pale grayish yellow in colour, while the smaller ones less than 8 mm long, are coloured dark red on the dorsal side. Probably this colouration may fade with growth. In the 6.5 mm long individual, gonads are still immature, although the genital capsules are formed dis-

tinctly, and only six branchial folds are observed on each side, of which the second and the sixth are lower than others.

16) *Pyura mirabilis* (v. DRASCHE). A single 30 mm long specimen collected at Kaburagi on Aug. 4, 1957.

17) *Herdmania momus* (SAVIGNY). A 19 mm long mature specimen collected at Sakaziri on Aug. 8, 1958, 25 and 34 mm long mature individuals from Takahama, collected on Aug. 13, 1956 and two, 16 and 19 mm long, mature specimens collected at Ôsima on Aug. 12, 1955.

18) *Boltenia echinata* (LINNAEUS), 1767

(Pl. XVI, figs. 32–37)

A single 17 mm long specimen attached to the surface of the 90 mm long specimen of *Polycarpa cryptocarpa* var. *kroboja.* The body is roughly oval in outline and slightly depressed dorso-ventrally. The test is leathery, irregularly grooved and provided with a number of protuberances of various length scattered sparsely on the surface. Three of these protuberances are especially long and arranged side by side near the posterior end of the body. All these protuberances and the basal portion of the body near the attachment surface are armed with short spinules less than 1 mm in length. Both apertures are 4-lobed, but quite sessile and hardly detectable. The test is dark red in colour, about 0.5 mm in thickness and the inner surface is deeply reddish purple on the dorsal side. The branchial aperture is subterminal and the atrial aperture is situated slightly posterior to the middle of the body. The mantle is of a moderate thickness and pale yellowish brown in colour. No endocarps are seen on the inner surface.

Branchial sac: Seven folds on the right and eight on the left side. The inner longitudinal vessels are arranged as follows:

Right D 2 (18) 1 (13) 1 (17) 1 (22) 3 (20) 2 (16) 3 (7) 1 V
Left D 1 (20) 1 (12) 1 (18) 1 (19) 3 (15) 3 (11) 3 (6) 1 (3) 0 V

The eighth one on the left side is formed only in the anterior portion of the sac. From fifteen to twenty-two stigmata between each pair of transverse vessels in the middle portion. Tentacles ca. 15 excluding minute ones; larger and smaller ones are differentiated; branches in two orders. The ciliated groove is U-shaped.

Alimentary system: The intestinal loop is very elongate. The anal margin is nearly plain and the opening itself is roughly U-shaped.

Gonad: An elongate gonad on each side, undulating somewhat in a zigzag course.

Remarks: The complete absence of characteristic spines on the body surface is very strange. However, I am inclined to identify the present specimen as a peculiar ecological form of *B. echinata,* living in somewhat warmer water, because there remain still a number of minute spinules and some protuberances on the test surface as mentioned above. Probably these may represent the vestigeal or rudimental stage of spines of typical *B. echinata*. And then, it is not impossible that this specimen might show an intermediate state between *B. echinata* and *B. isibasii* TOKIOKA which is known from Ôsaka Bay and quite devoid of any spine or spinule. Anyhow, it is very interesting that this cold-water species was found attached to the surface of a warm-water form, *Polycarpa cryptocarpa* var. *kroboja*.

19) *Halocynthia hilgendorfi* (TRAUSTEDT), 1885

(Pls. XVII–XVIII, figs. 38–47)

There are three specimens in the material dredged in Wakasa Bay, two of which are armed with branched spines over the whole surface of the body and apparently represent the external appearance of "*Halocynthia igaboja* (OKA)", while in the other one such spines are confined to only the areas surrounding the apertures and a small part of the body posterior to the atrial aperture and evidently shows the appearance of "*Halocynthia ritteri* (OKA)".

"*Igaboja*"–form (figs. 38–42): 18 mm and 20 mm long specimens. The body is roughly oval in outline, attached to the substratum by the posterior end. Both apertures are sessile, but their situations are easily detectable by thickets of spines so densely set. The spines attain to 5–7 mm in length, with many lateral spinules, and yellowish brown in colour, The test is soft leathery, 0.5 mm–2 mm in thickness and grayish brown or yellowish brown in colour, with somewhat pinkish tint in the smaller specimen. The inner surface and the section are grayish. The mantle is rather thick and pale yellowish in colour. Many endocarps are seen on the inner surface. Eight branchial folds on each side of the branchial sac in the smaller specimen, the eighth (ventral-most) is formed only in the anterior portion of the sac. Inner longitudinal vessels are arranged on the left side as follows (18 mm long individual):

D 1 (16) 1 (18) 1 (18) 1 (16) 1 (16) 1 (14) 1 (14) 1 (8) 1 V

Transverse vessels are arranged in the order of 1 3 3 3 2 3 3 3 1, where the numerals indicate the order of thickness. Parastigmatic vessels present. About five stigmata in usual meshes, but up to ten in wider meshes along the endostyle. Large tentacles ca. 15, being intervened by small ones at intervals; branches in 2 orders. The ciliated groove U-shaped, with both horns strongly curled in. The axis of the second intestinal loop passes through the oesophageal region. The oesophagus is long; the liver consists of two portions, the anterior part consisting of linear hepatic plications and the posterior area consisting of somewhat follicular hepatic lobules.

Anus plainly margined. Four mature gonads on each side in both specimens; they are united one another at the proximal end.

"*Ritteri*"–form (figs. 43–47): A 50 mm long individual attached to a large cluster of empty oyster shells by the ventral side. The animal seems to be contracted strongly, the whole body being somewhat ovoid in outline. Both apertures quite sessile. The test is hard leathery and dark reddish in colour; the surface is nearly smooth except for several irregularly formed grooves and a few short spines found very sparsely. The test attains to 6 mm in thickness on the ventral side, the inner surface is reddish. The spines are less than 5 mm in length and usually yellowish brown in colour; its core is slightly reddish near the basal portion. The mantle is pale yellowish and very thick, many endocarps are found on the inner surface. There are eight branchial folds in the posterior part of the sac, but two more folds are formed in the anterior portion. Inner longitudinal vessels are arranged as follows:

(In the posterior part on the left side)
D - (30) 2 (28) 3 (30) 4 (28) 3 (25) 4 (24) 2 (23) 2 (13) 1 V
(In the anterior part on the right side)
D - (29) 2 (27) 3 (30) 2 (28) 3 (28) 2 (24) 2 (23) 3 (20) 2 (17) 1 (9) 2 V

There is an intermediate transverse vessel between each pair of thicker ones, and then about fifteen small vessels at each interval between thicker and intermediate vessels. Parastigmatic vessels are seen in most meshes. Four to five stgmata in a mesh. Large tentacles 14, being intervened by small ones at intervals; branches in 2 orders. The ciliated groove is rosette-formed. The alimentary system is quite the same as that in the "*igaboja*"-form. Ten gonads on each side.

Remarks: Probably these three specimens belong to the "Formenkreis" represented by *Halocynthia hilgendorfi*, although it is still quite unknown about what causes such striking differences found in the external appearance. As to the relationship between the present third specimen and *Hal. pachyderma* (OKA), more crucial examinations on much more specimens should be necessary. *Hal. cactus* (OKA) and the present first two specimens of "*igaboja*"-form resemble each other very closely in the internal structure and also in the external appearance, but the structure of the spines seems to differ distinctly. However, if spines of these different appearances are proved to be continuous by the existence of some intermediate forms, then *Hal. cactus* might be included in the "Formenkreis" dealt with here.

20) *Microcosmus hartmeyeri* OKA. An 85 mm long specimen collected by a trawler of Kuriya Base. Large tentacles 17, small and minute ones ca. 13. The ciliated groove is C-shaped with both terminals strongly incurled. On the inner surface of the mantle on the right side, several large endocarps are arranged in a series.

21) *Microcosmus multitentaculatus* TOKIOKA, 1953

(Pl. XVIII, figs. 48-49).

A 40 mm long individual dredged in Wakasa Bay. The body is roughly ovoid and fastened to a large mass of gravels by the ventral side. Both siphons are short and situated on the dorsal side set side by side by contraction. The test is hard leathery and yellowish brown in colour, being sprinkled with reddish patches. Seven folds on each side of the branchial sac. Inner longitudinal vessels are arranged as follows ;

Right D 2 (23) 1 (21) 1 (23) 2 (21) 3 (19) 2 (18) 3 (14) 1 V

Large tentacles 17, the ciliated groove U-shaped slightly inclined to the right side and both horns curled in. The gonad on the right side is an oval mass, distinctly outlined and fully mature. The arrangement of endocarps differs quite from that found in *M. hartmeyeri*. This is the third specimen of this species. In spite of the specific name "*multitentaculatus*", the number of tentacles seems to be insignificant as a specific characteristic ; rather the shape of the gonad, the arrangement of endocarps and probably the appearance of the ciliated groove seem to be significant as clues differentiating the present species from *M. hartmeyeri*.

PYROSOMATA

1) *Pyrosoma atlanticum atlanticum* PÉRON, 1804. A 51 mm long and 14 mm wide (at the aperture) colony from Sagami Bay. Spiny protuberances on the surface are very distinct. Fifteen inner longitudinal bars on each side and 4 dorsal languets were observed on dissected zooids.

2) *Pyrosoma operculatum* NEUMANN, 1908. A 50 mm long and 29 mm wide, somewhat flattened colony from Sagami Bay. The surface of the colony is quite smooth. Nineteen inner longitudinal bars on each side and fourteen dorsal languets were observed on dissected zooids. These features seem to support the identity of this specimen with *P. operculatum*, although the existence of the characteristic operculum-shaped atrial protuberance could not be ascertained on account of the imperfect condition of preservation.

EXPLANATION OF PLATES XIII-XVIII

PLATE XIII

Figs. 1-5. *Homoeodistoma longigona* n. sp. 1—Colony, enlarged ; 2—Right side of a zooid excluding postabdomen, magnified ; 3—Junction between middle intestine and rectum, 4—Abdmen and postabdomen, magnified ; 5—Arrangement of pigment spots and bands at the anterior end of thorax, magnified. at.—atrial aperture, br.—branchial aperture, d.g.—dorsal ganglion, ed.—endostyle.

PLATE XIV

Fig. 6. *Ascidia zara* OKA. A part of test surface, showing three spiny protuberances, magnified.

Figs. 7-8. *Ascidia sydneiensis samea* (OKA). 7—29 mm long animal, 8—Branchial siphon, enlarged.

Figs. 9–14. *Polycarpa granosa* Tokioka. 9—72 mm long animal, 10–Right half of mantle body, from outside; 11—Left half of mantle body, inside; 12—Stomach, enlarged; 13—Ciliated groove, magnified; 14—Attachment surface of gonad, enlarged.

Plate XV

Figs. 15–20. *Polycarpa maculata* (Hartmeyer). 15—30 mm long animal, 16—Left half of mantle body, inside; 17—Right half of mantle body, inside; 18—Ciliated groove, magnified; 19—Anus, enlarged; 20—Attachment surface of gonad, enlarged.

Figs. 21–22. *Polycarpa cryptocarpa* var. *kroboja* (Oka). Ciliated grooves, magnified. 21—70 mm long individual, 22—90 mm long individual.

Fig. 23. *Cnemidocarpa areolata* (Heller). Right half of mantle body of 47 mm long individual, inside.

Fig. 24. ? *Cnemidocarpa areolata* (Heller) juv. Left half of mantle body of 2.5 mm long individual, inside.

Fig. 25. *Cnemidocarpa macrogastra* (Oka). Left half of mantle body of 26 mm long individual, inside.

Plate XVI

Figs. 26–29. *Cnemidocarpa fertilis* f. *minor* Tokioka. 26—Dorsal side of 10 mm long specimen, 27—Right half of mantle body, inside; 28–Left half of mantle body, inside; 29–Ciliated groove, magnified.

Figs. 30–31. *Styela esther* Hartmeyer. 30—Ciliated groove, magnified; 31—Anus, enlarged.

Figs. 32–37. *Boltenia echinata* (Linnaeus). 32—Dorsal side of 17 mm long individual, 33—Spinules from the basal portion of body, magnified; 34—Left half of mantle body, inside; 35—Right half of mantle body, inside; 36—Ciliated groove, magnified; 37—Anal opening, enlarged.

Plate XVII

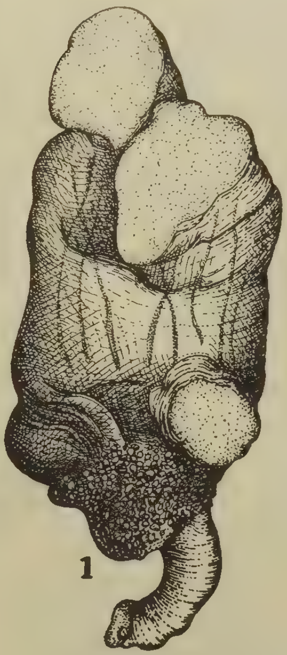
Figs. 38–42. *Halocynthia hilgendorfi* (Traustedt). "*igaboja*"-form 38—18 mm long animal, 39—Right half of mantle body (25 mm long individual), inside; 40–Left half of mantle body (18 mm long individual), inside; 41—Ciliated groove of 18 mm long individual, enlarged; 42—Ciliated groove of 25 mm long individual, enlarged.

Fig. 43. *Halocynthia hilgendorfi* (Traustedt). "*ritteri*"-form. One of spines around the branchial aperture, enlarged.

Plate XVIII

Figs. 44–47. *Halocynthia hilgendorfi* (Traustedt). "*ritteri*"-form. 44—50 mm long animal, 45—Left side of mantle body, inside; 46—Right side of mantle body, inside; 47—Ciliated groove, magnified.

Figs. 48–49. *Microcosmus multitentaculatus* Tokioka. 48—Right half of mantle body, inside; 49—Ciliated groove, magnified.



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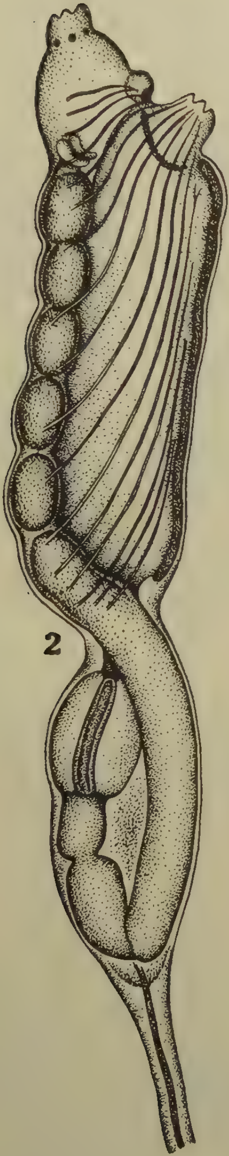

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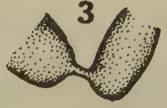

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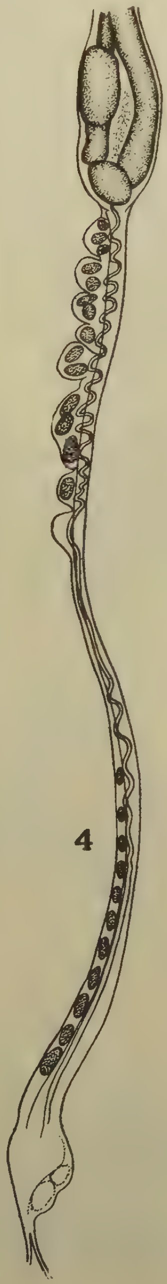

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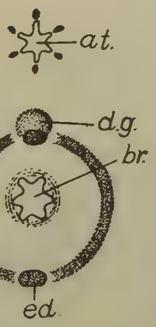

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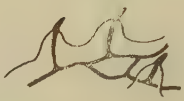

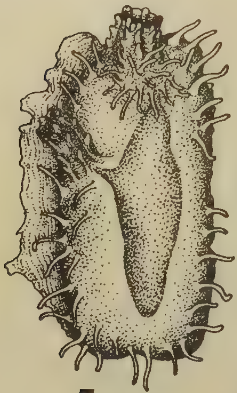

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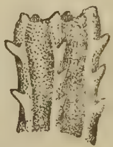

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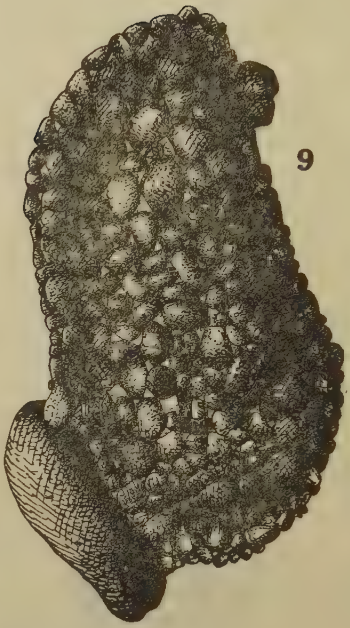

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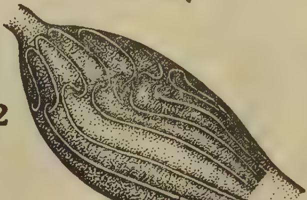

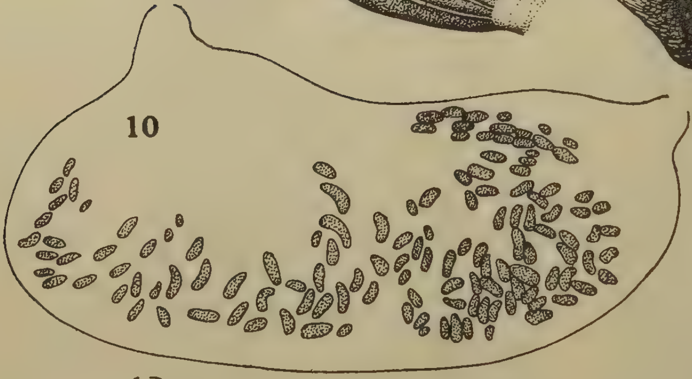

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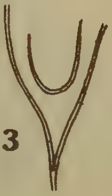

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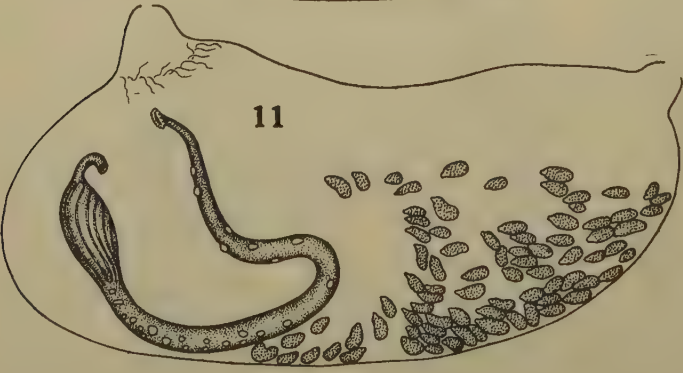

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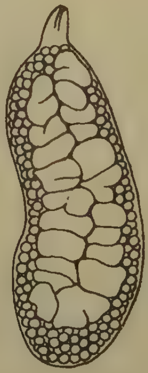

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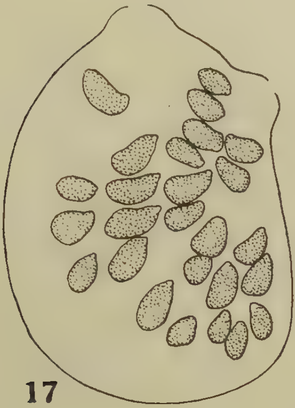

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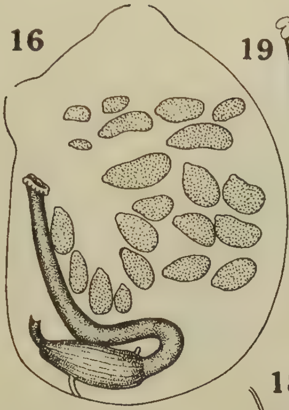

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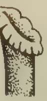

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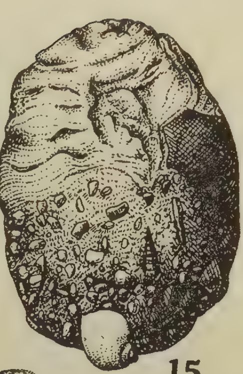

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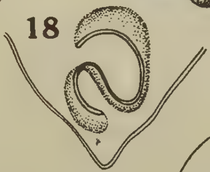

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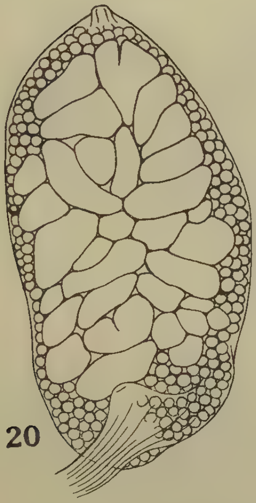

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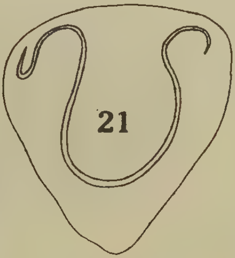

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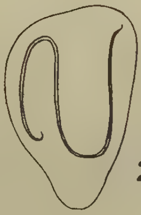

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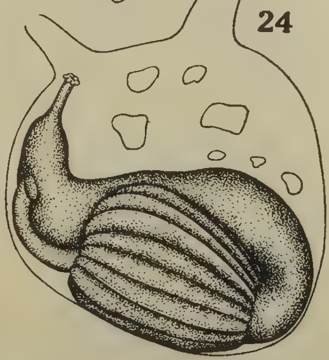

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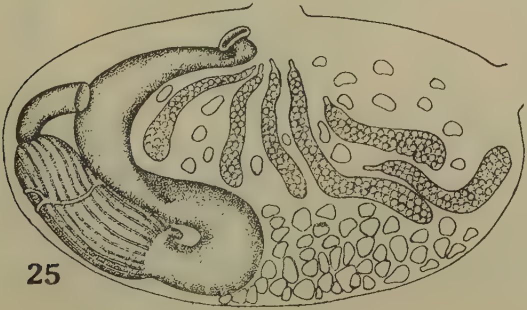

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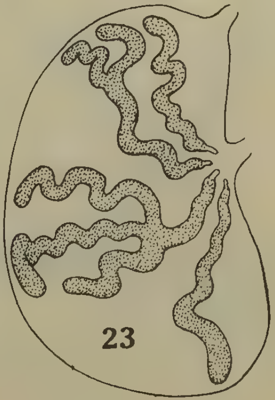

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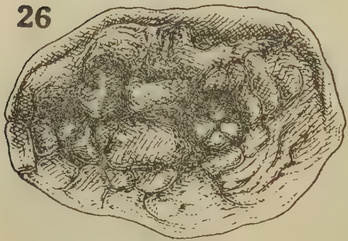

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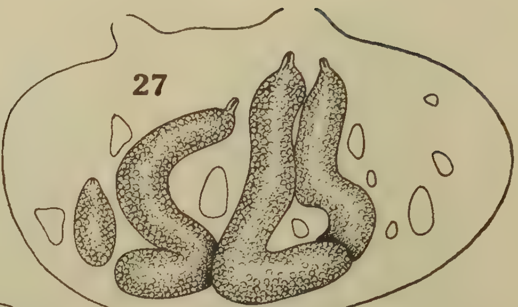

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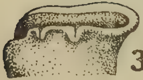

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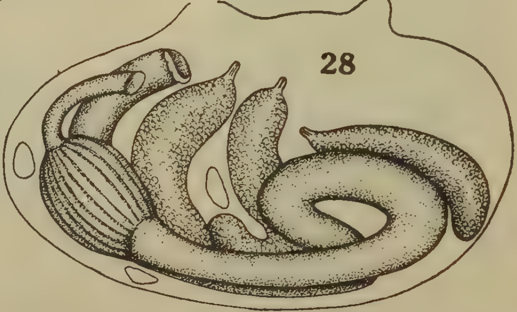

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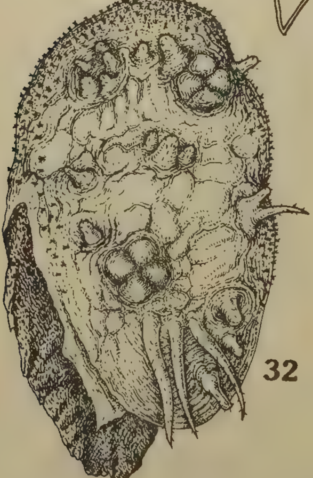

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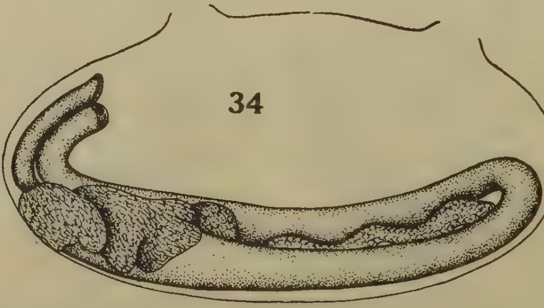

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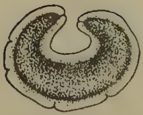

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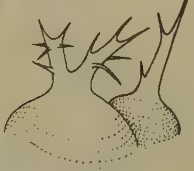

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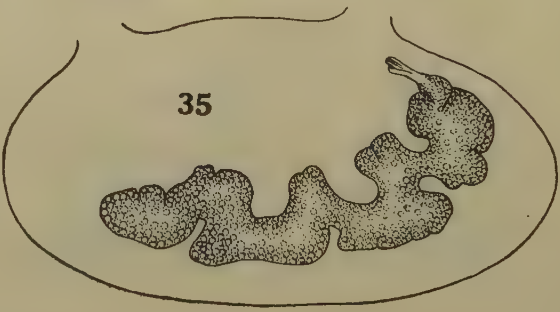

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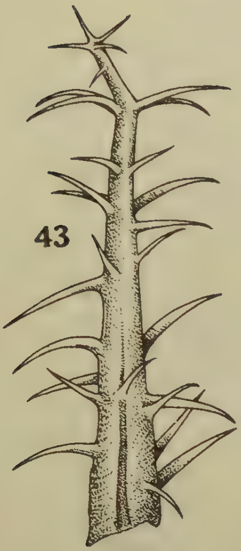
T. Tokioka: Contributions to Jaapnese Ascidian Fauna, XIII.

PLATE XVII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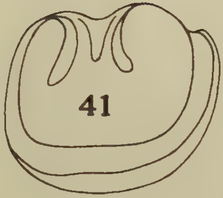
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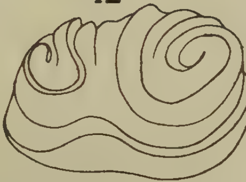
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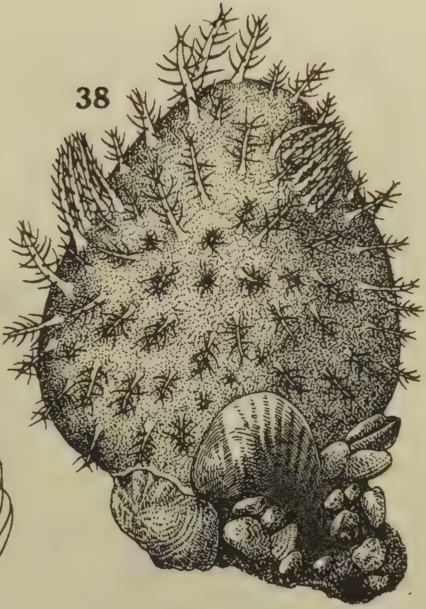
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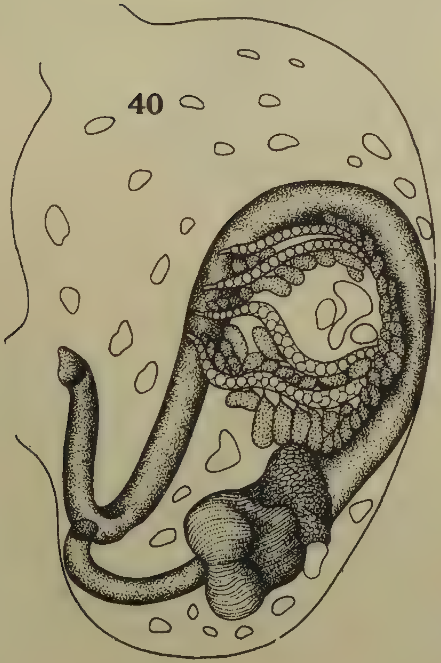
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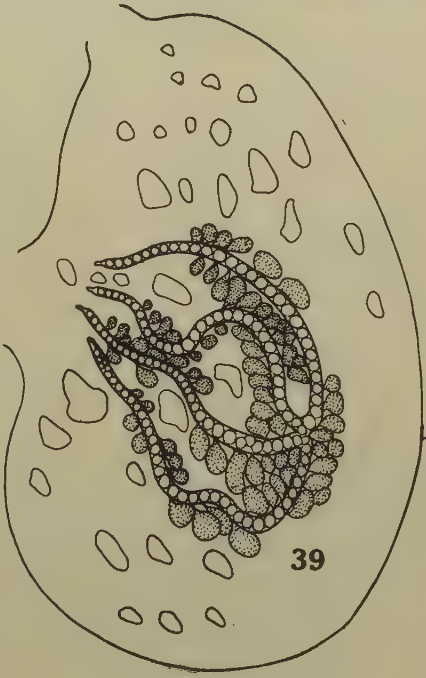
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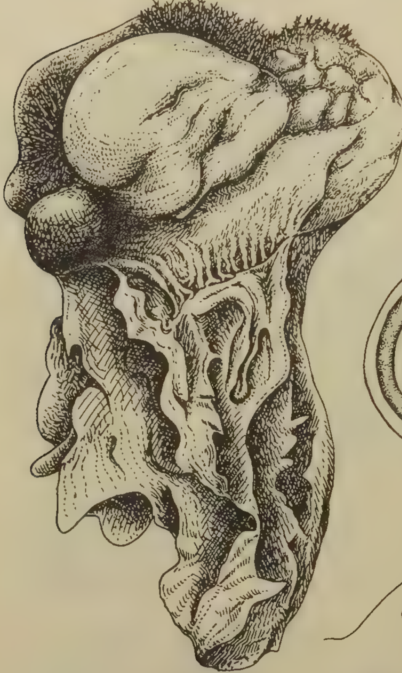
T. TOKIOKA: CONTRIBUTIONS TO JAPANESE ASCIDIAN FAUNA, XIII.



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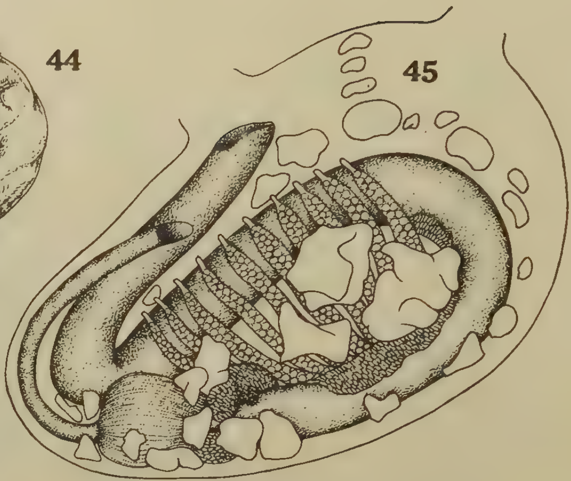

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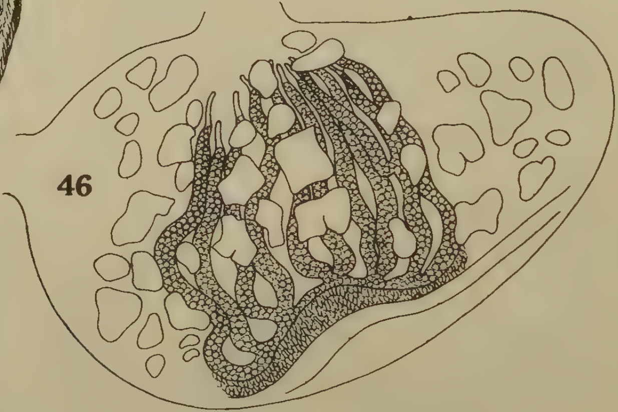

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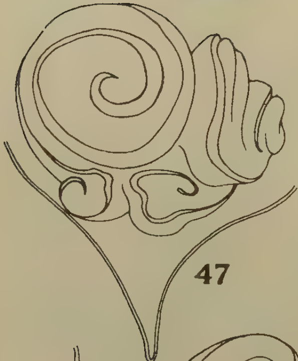

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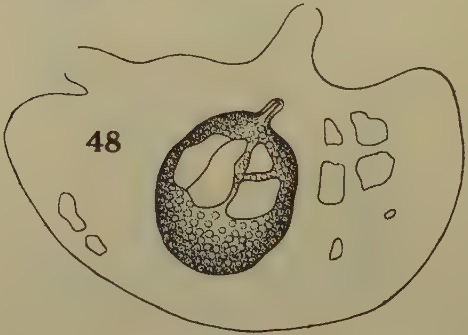

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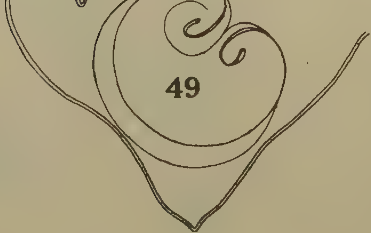

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T. Tokioka: Contributions to Japanese Ascidian Fauna, XIII.

CONTRIBUTIONS TO JAPANESE ASCIDIAN FAUNA

XIV. SPORADIC MEMORANDUM (5) ON TWO LARGE COLONIES OF COMPOUND ASCIDIANS DREDGED IN THE TYOSEN STRAITS[1]

Takasi TOKIOKA

Seto Marine Biological Laboratory, Sirahama

With Plate XIX and 1 Text-figure

I had a chance to examine two large colonies of compound ascidians which were dredged by the training boat of the Hiroshima University at a station in the Tyosen Straits, 85 m deep and ten miles east of Okinosima, on October 12, 1954. One is a colony, possibly referable to the "*Aphanibranchion*"-stage of *Syndiazona grandis* Oka, while the other one belongs to the genus *Amaroucium* and seems to represent a new species, the descriptions of which are given in the following. Before going further, I want to express my hearty thanks to Prof. Iwao Taki of the Hiroshima University, who collected these specimens and so kindly submitted them to my examination, and also to Dr. I. Yamazi of our laboratory, who prepared for me photographs of the plate.

1. *Amaroucium takii* n. sp.

(Text-fig. 1; Pl. XIX, figs. 3 and 4)

A gelatinous colony of 130 mm high, 130 mm wide and 30 mm thick, being compressed laterally and fastened to the sand mass by the under side, 85 mm long × 60 mm wide and 20–30 mm in thickness. The surface is nearly smooth and quite free from foreign matters. The test is of moderate hardness, translucent and pale pinkish brown in colour. Probably the colony might be much more swollen when it was alive. Zooids are arranged in groups, although the systems are not distinct; each group comprises 7–15 zooids.

Zooid: Zooids are very elongate, up to 23 mm in length in examined ones. The thorax is very small, only 1 to 1.2 mm in length in a considerably contracted state. The proportional length of the abdomen varies considerably according to the degree of contraction of both thorax and abdomen; it is about a half of the length of the thorax when it is short, but it may be as long as the thorax when it is long.

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[1] Contributions from the Seto Marine Biological Laboratory, No. 325.

Publ. Seto Mar. Biol. Lab., VII (2), 1959. (Article 11)

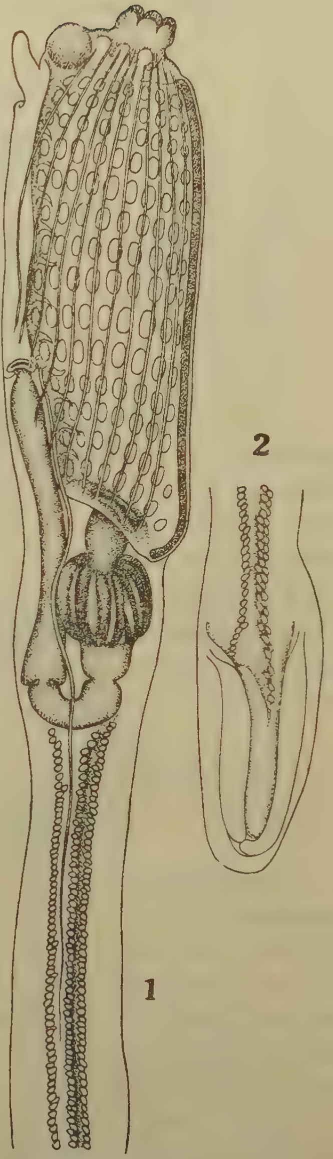
Thorax: Rather small. The branchial aperture 6-lobed, the atrial is situated approximately at the level of the third stigmatal row and provided with a short atrial languet pointed distally. Some zooids seem to be devoid of atrial languet. About a dozen longitudinal muscles on each side of the thorax. From twelve to fifteen stigmatal rows are present; and eight to ten stigmata in each row. Tentacles 6, dorsal languets are slightly displaced to the left side from the dorso-median line. The anus is located in the posterior part, three to four stimatal rows are found posterior to the level where the anus is attached.

Abdomen: The stomach is situated near the middle of the abdomen, roughly globular in outline and marked with about 15 longitudinal plications. The mid-intestine distinct; the proximal portion of the rectum is swollen and forms a pair of small coeca.

Postabdomen: Extremely long. Testicular follicles very small and numerous, being arranged in two pairs of longitudinal rows. The ovary was not found in any dissected zooids. The heart occupies the distal part of the postabdomen.

Remarks: Both the appearance of the colony and the structure of zooids of this specimen remind us of those of large colonies of *Am. glabrum* VERRILL and *Am. constellatum* VERRILL. From these VERRILL's species, however, the present specimen differs apparently in the number of stigmatal rows and that of stigmata in each row; namely VERRILL's species have fewer rows, but a little more stigmata in each row. In *Am. constellatum*, the stomach wall is marked with much more longitudinal plications.

Am. solidum RITTER & FORSYTH from the Californian coast of the U. S. resembles closely the present specimen, too. It has 13 to 15 stigmatal rows, but stigmata in each row attain to about 15 and the stomach has only ca. eight longitudinal plications. For these reasons, I am inclined, at present, to treat the present specimen as a new species.



Text-fig. 1. *Amaroucium takii* n. sp. 1···Thorax, abdomen and anterior part of postabdomen; right side, magnified. 2···Distal end of postabdomen, magnified.

2. ? *Syndiazona grandis* OKA

(Pl. XIX, figs. 1 and 2)

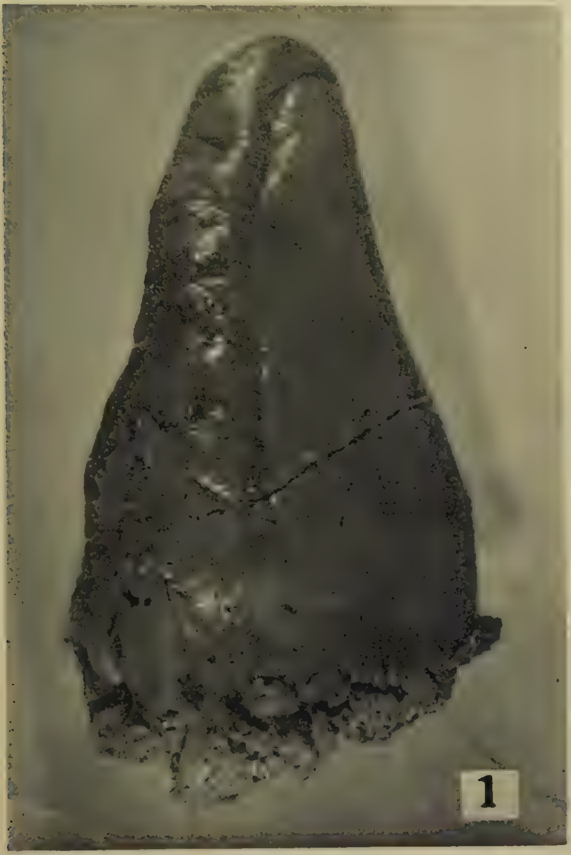
A big conical colony, about 250 mm in height and 160 mm in diameter across the basal surface from where many short root-like protuberances are issued and by which the colony is fastened to coarse sand grains. The tip of the colony is obtusely pointed. The test is hard gelatinous and dark grayish brown in colour. The surface is nearly smooth. The surface layer, about 20 mm in thickness, is occupied by zooids, while the wide inner core portion is completely filled with gelatinous test substance. Of the zooidal layer, inner 10 mm is occupied by abdomens. The thorax is very small, less than 2 mm in length. The thoracic musculature seems to consist of transverse muscles; about twenty stigmatal rows are defined. The abdomen is ca. 10 mm in length; the internal structure is quite obscured by mesenchyme cells which fill the whole abdomen and dark yellowish brown in colour.

Apparently, the rudimentary appearance of thoraces proves that the present colony shows the so-called "*Aphanibranchion*"-stage of a form of *Syndiazona*. And the possible arrangement of thoracic muscles alludes that the colony might belong to *S. grandis* OKA.

EXPLANATION OF PLATE XIX

Fig. 1. ? *Syndiazona grandis* OKA, 250 mm high colony.
Fig. 2. " " , longitudinal section of the same colony.
Fig. 3. *Amaroucium takii* n. sp., 130 mm high colony.
Fig. 4. " " , a part of the section of the same colony, slightly enlarged.

PLATE XIX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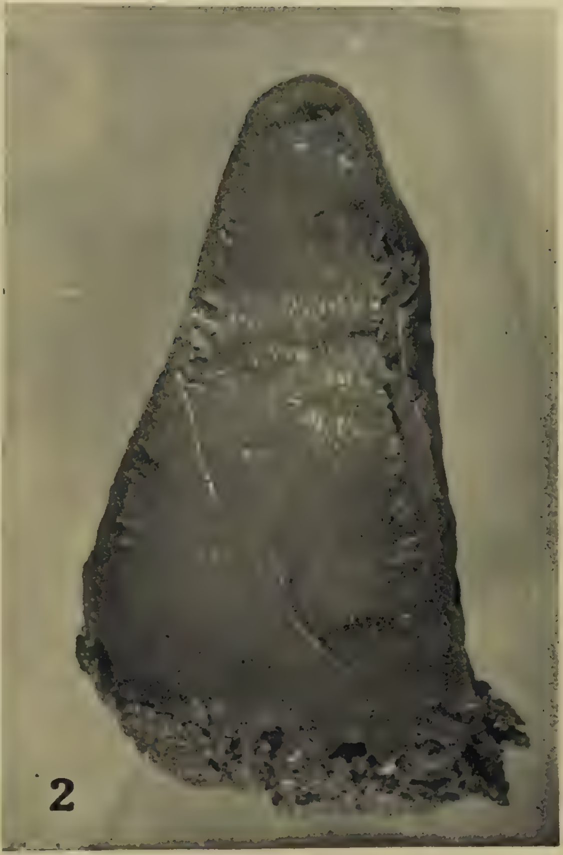
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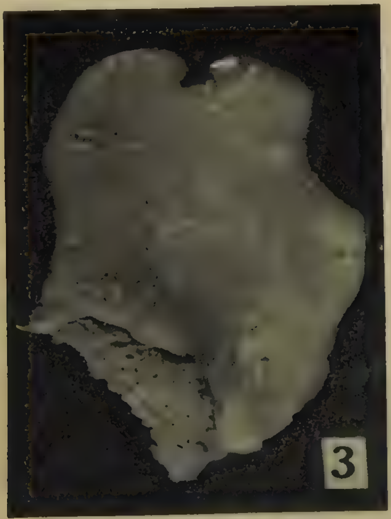
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T. TOKIOKA: CONTIRIBUTIONS TO JAPANESE ASCIDIAN FAUNA, XIV.

STUDIES ON THE HELMINTH FAUNA OF JAPAN

Part 54. TREMATODES OF FISHES, XIII

SATYU YAMAGUTI

Department of Parasitology, Okayama University
Medical School, Okayama

With Plates XX-XXI

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Publ. Seto Mar. Biol. Lab., VII (2), 1959. (Article 12)

BUCEPHALIDAE POCHE, 1907

1. *Bucephalus sebastichthydis* n. sp.

(Pl. XX, Fig. 1)

Habitat: Small intestine of *Sebastichthys pachycephalus* TEMM. et SCHLEG.

Material, locality and date: A single gravid specimen fixed in Schaudinn's solution under a cover slip; Enoshima Aquarium; June 5, 1958.

Body cylindrical, 3.45 mm long by 0.44 mm broad, covered all over with minute scale-like spines; subcuticular muscle well developed in forebody. Rhynchus 0.34 × 0.32 mm, consisting of coarse muscle bundles running perpendicularly to the surface of the organ and longer stouter bundles directed forward divergently from the base, provided along its anterior margin with a half-crown of seven, bifurcate, conical, horn-like processes 65–80 μ long by 40 μ broad at base. The above mentioned muscle bundles of the rhynchus do not extend into these horn-like processes. Mouth opening about midregion of body, pharynx $80 \times 90\mu$; intestine turning back on itself a short distance anterior to pharynx and then descending to level of ovary.

Testes subglobular to oval, situated a little obliquely one behind the other in anterior part of caudal third of body; the anterior 0.21 × 0.16 mm, lying on the right a little behind ovary and the posterior 0.18 × 0.17 mm, at base of cirrus pouch; two vasa efferentia uniting together at level of anterior end of posterior testis. Cirrus pouch subcylindrical, 0.5 × 0.11 mm, provided with a coat of strong longitudinal muscle bundles; seminal vesicle elongate saccular, about 0.13 mm long, 52μ broad; pars prostatica about 0.39 mm long, prostate cells filling up all available space of cirrus pouch. The genital lobe, through which the ejaculatory duct passes, is crooked to the right, with its concavity directed toward the uterine opening. Genital atrium funnel-shaped, about 0.1 mm in diameter, opening ventrally at a distance of 0.11 mm from rounded posterior end of body.

Ovary 0.19 × 0.13 mm, situated on the right a little posterior to pharynx. The germiduct arising from the dorsal side of the ovary forms near its origin a bulbous swelling 32μ wide, and then gives off the Laurer's canal at the point where it turns abruptly to the right. After joining the common vitelline duct it is surrounded by shell gland cells behind the ovary and thrown into convolutions, the proximal part of which contains abundant spermatozoa. Uterine coils reaching forward a little beyond anterior limit of vitellaria, occupying most of space between this level and posterior extremity, and opening into genital atrium opposite concavity of genital lobe; eggs oval, $23\text{–}26 \times 13\text{–}16\mu$. Anterior vitelline follicles extending along each lateral margin of body, commencing at about junction of anterior with middle third of body; posterior follicles of each side tending to approach median line; right ones 13 in number, terminating medial to ovary; left ones 20 in number, reaching to near posterior testis; right descending duct and left ascending duct unites with each other at level of anterior end of anterior testis. Excretory vesicle wide, tubular, extending into anterior third of body; pore terminal.

This species, characterized by the seven bifurcate tentacular processes of the rhynchus, bears a certain resemblance to *Bucephalus aoria* VERMA, 1936, or *B. tridentacularia* VERMA, 1936, but differs from either of them in the relative position of the digestive and reproductive organs. In the latter respect as well as in general body shape it resembles *B. scorpaenae* MANTER, 1940, only differing in the character of the tentacular processes and the posterior extent of the vitellaria.

2. *Rhipidocotyle sphyraenae* n. sp.

(Pl. XX, Figs. 3-4)

Habitat: Small intestine of *Sphyraena pinguis* GÜNTHER.

Material, locality and date: 8 gravid specimens; Sagami Bay; June 7, 1958.

Body subcylindrical, 0.9-1.7×0.16-0.26 mm, covered all over with minute scale-like spines. Rhynchus bowl-shaped, 0.07-0.11 mm long by 0.095-0.14 mm broad, with comparatively thin-walled muscular base and a semicircular apical hood, which is provided along its convex margin with a row of seven double papillae at nearly equal intervals and terminates on each side in an inwardly directed blunt point. Pharynx 46-52μ in diameter, just pre-equatorial. Intestine elongated saccular, terminating at level of anterior part of ovary.

Testes oval, tandem, postequatorial, to right of median line, 0.08-0.16×0.06-0.12 mm; posterior testis on the right of base of cirrus pouch. Cirrus pouch subcylindrical, 0.23-0.35×0.04-0.06 mm, extending on the left nearly whole length of caudal third of body, its wall consisting of longitudinal muscle bundles; seminal vesicle oval, at base of cirrus pouch; prostatic complex occupying greater part of cirrus pouch; ductus ejaculatorius strongly muscular, winding at distal end of cirrus pouch, may be everted into genital atrium in form of a stout cirrus when the cirrus is protruded; the reduced genital lobe is seen at the base of the cirrus. Genital pore ventral, with thick cuticular lining, 50-80μ from posterior tip of body.

Ovary subglobular, 0.07-0.12×0.05-0.1 mm, postequatorial, on the right immediately in front of anterior testis. Uterine coils ascending far forward to near rhynchus; eggs oval, 18-21×13-14μ. Vitelline follicles lateral, numbering about 10 on the right, but more numerous on the left; right follicles terminating at level of pharynx, left posterior follicles dorsal to uterus, extending as far backward as anterior testis. Excretory vesicle long, tubular, wide, reaching to near anterior end of uterus; pore terminal.

This species differs from the most closely related *R. barracudae* MANTER, 1940, from *Sphyraena barracuda* in the apical hood of the rhynchus being provided with seven marginal double papillae. In *R. barracudae* the apical hood is pentagonal, and apparently devoid of papillae.

3. *Dolichoenterum magnum* n. sp.

(Pl. XX, Fig. 2)

Habitat: Small intestine of *Conger conger* LINNÉ.

Material: Three gravid specimens fixed under cover glass pressure, stained and mounted as usual, 16–20×1.4–2.0 mm.

Locality and date: Shinmaiko, Aquarium of Tokyo University; May 13, 1958.

Body elongate, more or less attenuated in region between mouth and anterior end of uterus, truncate in front and blunt-pointed behind. Cuticle densely beset all over with scale-like spines. In addition to the longitudinal subcuticular musculature which extends throughout the body, there are diagonal muscle fibers which are particularly well developed in the region between the rhynchus and the mouth opening. Rhynchus terminal, with wide ventral opening and a dorsal half-crown of 8 blunt-conical muscular protuberances, 0.7–1.0×0.9–1.1 mm. Mouth opening midventrally at a distance of 2.7–4.0 mm from anterior extremity, leading into pharynx by way of a vestibule. Pharynx muscular, 0.3–0.35×0.37–0.4 mm; intestine at first ascending a short distance, then turning back on itself to descend in the median field to near middle of body where it is shifted dorsolaterad by the uterus and terminates short of the anterior testis.

Testes rounded, wide apart in posterior third of body, the anterior (0.8×0.7–1.0 mm) on the right at about anterior end of posterior third of body, the posterior (0.6–0.9×0.85–1.2 mm) slightly to left of median line in front of base of cirrus pouch. Cirrus pouch fusiform, strongly muscular, 1.5–1.7×0.5 mm, at posterior extremity. Seminal vesicle large, oval, 0.6–0.7×0.36–0.4 mm, at base of cirrus pouch; prostatic complex occupying rest of cirrus pouch. A large genital lobe projecting into genital atrium, which opens midventrally at the posterior end of the body.

Ovary rounded, 0.5–0.75×0.6–0.7 mm, situated behind anterior testis, from which it is separated by a uterine coil. Shell gland complex immediately postovarian. Uterus thrown into very close transverse coils, reaching to midregion of body, where it turns backward and occupies all available space between other genital organs and body wall, finally it runs down alongside the cirrus pouch and opens into the genital atrium; eggs elliptical, 18–20×11–13μ. Vitelline follicles extend along each side of body at irregular intervals; right ones 20–22 in number, from equatorial zone to level of posterior testis; left ones 14–17 in number, less extensive than right ones, terminating at level of ovary or shell gland. Excretory vesicle tubular, wide, reaching to midregion of body, slightly beyond anterior end of uterus; pore dorsoterminal.

This species is characterized by its enormous size, to which the specific name refers. It differs from *D. longissimum* OZAKI, 1924, from the related fish host, in the posterior extent of the cecum and in the much smaller size of the eggs, in addition to the difference in body size. The description by TENDEIRO of *Dolichoenterum manteri* from a Portuguese conger eel was not available.

ALLOCREADIIDAE STOSSICH, 1903

4. *Decemtestis parapercis* n. sp.

(Pl. XX, Fig. 6)

Habitat: Small intestine of *Parapercis pulchella* TEMM. et SCHLEG.

Material: Two gravid specimens fixed in Schaudinn's solution under a cover slip and stained with Heidenhain's hematoxylin.

Locality and date: Ise Bay; May 12, 1958.

Body spatulate, broadly rounded or truncate behind, 2.7–2.8 mm in length, with maximum width of 0.83–1.25 mm behind middle. Cuticle thin, unarmed. Oral sucker subterminal, 0.22–0.23 × 0.23–0.24 mm, prepharynx distinct; pharynx subglobular to subcylindrical, 0.1–0.12 × 0.12–0.15 mm; esophagus 70μ long; ceca terminating at posterior extremity. Acetabulum 0.31–0.35 × 0.33–0.38 mm, situated at anterior part of middle third of body.

Testes subglobular or irregular in shape, 0.14–0.17 × 0.17–0.3 mm, six on right side of median line in the type. In the syntype, however, there are four on the right in a longitudinal row, and five on the left in a zigzag row. Cirrus pouch tubular, 1.0–1.15 × 0.08–0.11 mm, extending a short distance back of acetabulum just beyond equatorial level; seminal vesicle tubular, twisted or sigmoid, with maximum width of 85μ at base, with its narrow distal portion convoluted. Pars prostatica apparently not differentiated; cirrus with corrugated surface. Genital pore sinistral to esophagus.

Ovary irregularly lobed, 0.27–0.3 × 0.3–0.32 mm, situated just medial to right cecum between acetabulum and right anteriormost testis. Seminal receptacle retort-shaped, 0.07–0.11 mm wide at base, immediately posterodorsal to ovary. The germiduct arising from the dorsal surface of the ovary joins the seminal receptacle at its attenuated distal end and then turns backward to receive the vitelline duct from the vitelline reservoir lying immediately behind the origin of the Laurer's canal. The Laurer's canal, originating from the distal end of the seminal receptacle just opposite the point of junction of the germiduct with the seminal receptacle, runs transversely to the left dorsal to the uterus and opens dorsally just behind the posterior end of the cirrus pouch. Uterine coils intruding into space between anterior testes and occupying whole space bounded by left anteriormost testis, ovary and acetabulum, then ascending on left side of cirrus pouch; metraterm well differentiated, muscular. Eggs oval, thin-shelled, 54–62 × 33–39μ. Vitellaria extending in lateral fields from level of pharynx to posterior extremity, confluent across esophagus and behind intestinal bifurcation, but separated behind testes by excretory vesicle; vitelline reservoir dorsal to left lobe of ovary in the type, but more medial in the syntype. Excretory vesicle tubular, with ventroterminal pore; it cannot be followed to its anterior end owing to excessive development of the uterus.

This species resembles *D. callionymi* YAMAGUTI, 1934, in general anatomy, especially in the long cirrus pouch and in the intertesticular extent of the uterus, but differs from it in the vitellaria not being interrupted at the acetabular level.

5. *Maculifer chilomycteri* n. sp.

(Pl. XXI, Fig. 11)

Habitat: Small intestine (lower part) of *Chilomycterus affinis* GÜNTHER.

Material: One gravid specimen and one senile specimen, both fixed in Schaudinn's solution under a cover slip, 3.9–4.7×2.6–3.3 mm.

Locality and date: Aquarium of Seto Marine Biological Laboratory, Shirahama; April 5, 1958.

Body flattened oval, blunt-pointed in front, rounded behind, with or without median posterior notch. In the type a pair of flat conical cuticular protuberances is seen at the posterior extremity, but in the senile specimen two similar protuberances are seen on either side of the median notch. Oral sucker cuboidal, 0.4–0.52×0.52–0.6 mm, surmounted by preoral lobe containing glandular tissue. In the type a pair of gland ducts about 0.1 mm apart from each other is seen opening on this preoral lobe. Postoral ring consisting exclusively of transverse muscle fibers enclosing posterior end of oral sucker as well as anterior part of prepharynx, from which it is separated by a considerable free space. Prepharynx 0.25-0.3 mm long by 0.4-0.55 mm wide, pharynx ring-shaped, 0.32–0.45×0.6–0.78 mm, esophagus short and wide, 0.1×0.42 mm in the type, bifurcating at junction of anterior with middle third of body. Ceca wide, simple, terminating close to each other at posterior extremity. Acetabulum 0.67–0.83×0.78–1.0 mm, embedded in body parenchyma at junction of middle with posterior third of body.

Testes oval, 0.34–0.4×0.5–0.6 mm, situated subsymmetrically at about middle of postacetabular region with their long axes oblique to body axis, each pressed against inner side of cecum of its own side. Cirrus pouch approximately fusiform, 0.7–0.75×0.16–0.17 mm, tapered posteriorly, situated obliquely a little in front of acetabulum, containing tubular N-shaped seminal vesicle, poorly differentiated cylindrical pars prostatica (0.13 mm long by 30μ wide in the type) surrounded by clear prostatic cells and a narrow ductus ejaculatorius lined with thick smooth cuticle. Genital pore opening midventrally at intestinal bifurcation at base of a circular pit.

Ovary subglobular, 0.16-0.23×0.26–0.3 mm, in direct contact with right testis on its anteromedial surface. The germiduct arising from the anteromedial side of the ovary forms a bulbous swelling before turning back on itself and after joining the seminal receptacle proceeds forward to unite with the duct from the vitelline reservoir behind the posterior end of the acetabulum, where the shell gland cells are massed together. Seminal receptacle elongate, directly anteromedial to ovary; its inner posterior end tapers to the Laurer's canal which turns back itself and runs obliquely forward crossing the germiduct dorsally, and opens dorsally a little in front of ovary. The proximal descending portion of the uterus passes between the two testes and turning back on itself follows an ascending course between the ovary and the acetabulum and then along the right border of the acetabulum, and finally alongside the cirrus pouch on its left side. The uterus proper contains two or more rows of eggs, but the narrower metraterm a single row; egg oval to elliptical, 68–91×46–56μ. Vitellaria surrounding ceca on all sides, commencing on the right at level of prepharynx but on the left at level of pharynx, meeting in median line both dorsally and ventrally at intestinal bifurcation and on dorsal side of hindbody; vitelline reservoir rounded, comparatively small, anterosinistral to ovary.

Excretory vesicle elongate saccular, reaching to dextrodorsal side of acetabulum; pore terminal.

6. *Maculifer pacificus* YAMAGUTI, 1938

A single gravid specimen was found in the gall bladder of *Spheroides pardalis* from Sagami Bay. As pointed out in my original description this species is easily distinguished from *Maculifer japonicus* LAYMAN, 1930, by the eggs measuring 57–75 ×36–42μ as against 78–91×42–51μ. It is interesting to note that trematodes which are normally parasitic in the gastro-intestinal tract may occasionally be found in the gall bladder.

7. *Pedunculacetabulum opisthorchis* YAMAGUTI, 1934

As fixed in Schaudinn's solution under a cover slip and stained with Heidenhain's hematoxylin the three gravid specimens from *Hoplognathus fasciata* from Sagami Bay gave the following measurements in mm.

Body 2.7–0.5×0.45–0.55, oral sucker 0.12–0.21×0.17–0.23, pharynx 0.11–0.16×0.11–0.18; acetabulum 0.15–0.2 in diameter; testes 0.47–0.6×0.21–0.32, cirrus pouch 0.55–0.7 ×0.11–0.15; ovary 0.11–0.18×0.16–0.2; eggs 0.056–0.062 long.

8. *Plagioporus* (*Plagioporus*) *apogonichthydis* YAMAGUTI, 1938

Four gravid specimens of this species were found in the small intestine of *Apogon semilineatus* TEMM. et SCHLEG. from Sagami Bay, June 6, 1958. As fixed in Schaudinn's solution under a cover glass, stained and mounted, they gave the following measurements.

Body 0.94–1.4×0.45–0.55 mm, oral sucker 0.1–0.13 mm in diameter, pharynx 40–50 ×60–65μ, esophagus 50–70μ, acetabulum 0.2–0.3×0.24–0.27 mm, testes 0.09–0.16×0.16–0.26 mm, cirrus pouch 0.25–0.27×0.05–0.08 mm, reaching to dorsal side of anterodextral part of acetabulum, ovary 0.09–0.1×0.14–0.17 mm, receptaculum seminis 50–60μ wide, eggs 53–55×33–35μ.

As compared with my original description of the species the present material probably shows the lowest limit of variation instead of representing a new species or subspecies, because of complete agreement in disposition of all organs and in egg size. The present host is also very closely related to the type host.

9. *Plagioporus (Plagioporus) kyusen* n. sp.

(Pl. XX, Fig. 7)

Habitat: Small intestine of *Halichoeres poecilopterus* TEMM. et SCHLEG.

Material: Six, mostly macerated, gravid specimens fixed in Schaudinn's solution and stained with Heidenhain's hematoxylin.

Locality and date: Aquarium of Tokyo University at Shinmaiko on Ise Bay.

Body approximately fusiform, more tapered anteriorly than posteriorly, 0.65–0.9 mm in length, with maximum breadth of 0.22–0.3 mm behind middle. Cuticle thin and smooth. Oral sucker subterminal, 24–32μ in diameter, followed by distinct prepharynx; pharynx 14–17×14–19μ, esophagus 26–52μ long; ceca terminating near posterior extremity. Acetabulum 0.12–0.18 mm in diameter, nearly equatorial.

Testes subglobular, 56–104×56–130μ, obliquely tandem in posterior third of body, the anterior on the left, the posterior a little to the right. Cirrus pouch subcylindrical, 0.2–0.34 mm long, 46μ wide at posterior swelling, extending from dorsal side of anterior part of acetabulum to genital pore, containing winding tubular seminal vesicle, poorly differentiated pars prostatica, prostate cells and straight ejaculatory duct. Genital pore sinistral to intestinal bifurcation.

Ovary transversely elongated oval, 31–44×44–56μ, situated on the right just in front of posterior testis. Seminal receptacle spherical, 36×44μ in the type, immediately anterodorsal to ovary. The germiduct arising from the right end of the ovary joins the seminal receptacle at its posterior end, whence it turns forward across the seminal receptacle and then receives the duct from the vitelline reservoir. Laurer's canal is unable to trace to its dorsal opening.

Uterus distended with large eggs in the area bounded by anterior testis, shell gland, acetabulum and left cecum; metraterm well differentiated; eggs oval, very large as compared with body size, measuring 59–67×36–40μ. Vitelline follicles co-extensive with ceca, commencing at level of genital pore, not confluent in posttesticular area; vitelline reservoir triangular, anterosinistral to ovary. Excretory vesicle tubular, reaching to level of ovary; pore terminal.

This species is characterized by small body size and comparatively large egg size. The specific name is the Japanese name for the host.

10. *Plagioporus (Caudotestis) parapercis* n. sp.

(Pl. XX, Fig. 5)

Habitat: Small intestine of *Parapercis pulchella*.

Material: Four gravid specimens fixed in Schaudinn's solution under cover glass pressure, stained and mounted as usual.

Locality and date: Aquarium of Tokyo University at Shinmaiko; May 12, 1958.

Body flattened fusiform, with blunt-pointed extremities, 1.4–2.0 mm in length with maximum width of 0.55–0.9 mm at midregion. Cuticle thin and smooth. Oral sucker ventroterminal, 0.1–0.14×0.11–0.17 mm; prepharynx distinct, pharynx 0.04–0.1×0.06–0.11 mm, esophagus 0.1–0.14 mm long. Ceca terminating one on each side of posterior testis. Acetabulum 0.19–0.3×0.24–0.34 mm, a little anterior to middle of body.

Testes subglobular to ovoid, 0.1–0.3×0.15–0.44 mm, slightly obliquely tandem at about middle of posterior half of body. Vasa efferentia penetrating base of cirrus pouch separately. Cirrus pouch subcylindrical to claviform, 0.2–0.35×0.05–0.08 mm; with well developed longitudinal musculature, reaching to acetabulum or not; seminal vesicle tubular, winding at swollen basal portion of cirrus pouch, with its distal end sharply constricted off from pars prostatica; latter subcylindrical, about 20μ wide in the type, leading imperceptibly into ductus ejaculatorius. Genital pore sinistral to esophagus.

Ovary 0.12–0.25 mm in diameter, divided into three or more rounded lobes, situated anterodextral to anterior testis, just postequatorial. The germiduct, arising dorsally from the center of the ovary, describes an N-shaped loop, and at its second turn joins the seminal receptacle and Laurer's canal; the seminal receptacle is constricted into two parts, both being ciliated and containing yolk granules, and lies posterosinistral to the ovary; the Laurer's canal, running dorsal to the uterus, opens outside on the left of the median line about midway between the anterior testis and the acetabulum. Sigmoid uterine coils occupying most of space bounded by ovary, anterior testis and acetabulum and ascending sinistrodorsal to acetabulum and then alongside cirrus pouch; metraterm somewhat muscular; eggs oval, thin-shelled, 56–68×39–52μ. Vitelline follicles compratively large, extending in lateral fields from level of esophagus or pharynx to posterior extremity, confluent across esophagus and intestinal bifurcation; vitelline reservoir immediately in front of anterior testis to left of ovary. Excretory stem may or may not reach to dorsal side of posterior testis; pore terminal.

This species differs from the most closely related *Plagioporus* (*Caudotestis*) *sinitsini* MUELLER, 1934, in the host species as well as in the size and shape of the eggs. In *P. sinitsini* the host is a freshwater fish, and the eggs are ellipsoidal, measuring 70μ by 35μ.

11. *Opechona sebastodis* (YAMAGUTI, 1934)

The following redescription is based on 15 gravid specimens from *Sebastodes güntheri* from the Inland Sea, and 7 specimens from *Sebastodes schlegelii* from Sagami Bay. They were fixed in Schaudinn's solution under cover glass pressure, stained with iron-hematoxylin and mounted in balsam as usual.

Body rather slender, more tapered anteriorly than posteriorly, 3.6–6.6 in length, 0.36–0.65 mm in maximum width at level of ovario-testicular region, covered all over with small scale-like spines. Oral sucker ventroterminal, 40–90×52–106μ, more or less drawn out posteriorly. Prepharynx 0.05–0.3 mm long, with dissociated ocular pigment granules on each side. Pharynx barrel-shaped, 50–106×36–80μ. Esophagus narrow, 0.4-2.0 mm long, bifurcating slightly in front of acetabulum; ceca simple, terminating at posterior extremity. Acetabulum 0.1-0.14 mm in diameter, situated in second sixth of body.

Testes rounded, 0.23-0.55×0.18-0.42 mm, situated one behind the other in the intercecal field; anterior testis at posterior end of middle third of body, posterior one at anterior part of posterior third of body. Vesicula seminalis externa tubular, twisted at posterior end of anterior third of body, elongate saccular when distended. Cirrus pouch claviform, 0.26-0.7×0.05-0.1 mm, with muscular wall, extending for most part posterior to acetabulum. Vesicula seminalis interna oval, 65-104×50-80μ; pars prostatica strongly developed, oval to cuboidal, 52 85×65-83μ; ductus ejaculatorius muscular, lined with thick cuticle, more or less winding. Genital pore immediately anterosinistral to acetabulum.

Ovary rounded or trilobate, 0.15-0.27×0.16-0.3 mm, in front of anterior testis, from which it is separated by seminal receptacle, vitelline reservoir and some vitelline follicles intruding into the space. The germiduct arising from the dorsal side of the ovary forms a slight fusiform swelling and then joins the ascending duct from the seminal receptacle, and after turning back on itself unites with the vitelline duct ascending from the vitelline reservoir; ootype situated anterodorsal to ovary. Seminal receptacle oval to retort-shaped, situated posterodorsal to ovary and dorsal to vitelline reservoir. The Laurer's canal originating from the duct of the seminal receptacle just before the latter joins the germiduct, proceeds windingly or straight backward and opens dorsally in the left submedian line at the level of the seminal receptacle. Uterine coils occupying all available space of intercecal field between ovary and vesicula seminalis externa. Metraterm very strongly muscular, winding forward alongside cirrus pouch. As fixed in alcohol and measured in water the elliptical thin-shelled eggs are 65-78μ long by 45-50μ broad. Vitelline follicles surrounding ceca on all sides usually commencing at level of vesicula seminalis externa, occasionally a little more anteriorly or posteriorly, and terminating at posterior extremity, confluent in median line in inter- and posttesticular regions; some follicles approaching median line or confluent in the space between ovary and anterior testis; the anterior extent of the two preovarian lateral follicles is variable individually, and not always at the same level even in the same individual. Vitelline reservoir ventral to seminal receptacle behind ovary; the common vitelline duct, arising from the anterior or anterosinistral end of the reservoir, passes forward crossing the germiduct ventrally. Anterior extent of excretory vesicle unable to determine; pore terminal.

The minor differences in measurements between my original material of 1934 and the present one are due to the difference in technique employed.

12. *Opegaster macrorchis* YAMAGUTI, 1938

Habitat: Small intestine of *Parapercis ommatura* JORDAN et SNYDER.
Locality and date: Inland Sea; May 12, 1958.

Two gravid specimens fixed in Schaudinn's solution under cover glass pressure gave the following measurements.

Body 1.9–2.1×0.57–0.64 mm, oral sucker 0.12–0.13×0.15–0.16 mm, pharynx 0.09–0.1 ×0.07–0.08 mm, esophagus about 50μ long; anus about 75μ from posterior end of body; acetabulum 0.26–0.28 mm in diameter, with three papillae on anterior and posterior free border respectively. Testes indented, directly tandem behind equator, 0.25–0.3× 0.42–0.46 mm; seminal vesicle swollen at base to maximum width of 0.16 mm, reaching to level of middle or posterior end of acetabulum; cirrus pouch 104×40μ; genital pore sinistral, level with esophagus. Ovary transversely elongate, 0.1–0.12×0.3–0.31 mm, slightly to right; Laurer's canal forming a loop before opening dorsal to ovary behind vitelline reservoir or immediately anterior to ovary to left of vitelline reservoir. Uterus coiled between ovary and acetabulum; metraterm well differentiated; eggs 56–65×39–42μ. Vitellaria extending in lateral fields from level of genital pore to posterior extremity, confluent in posttesticular region; vitelline reservoir transversely elongated or triangular, anterodorsal to ovary. Excretory vesicle reaching to posterior end of ovary.

As compared with the original material of this species from *Neopercis multifasciata*, the pharynx is longer than broad and the esophagus is very short in the present material, but this difference is probably due to different state of contraction of these organs.

13. *Opegaster elongata* n. sp.

(Pl. XXI, Fig. 10)

Habitat: Small intestine of *Apogon semilineatus* TEMM. et SCHLEG.

Material: A single gravid specimen fixed in Schaudinn's solution, stained and mounted.

Locality and date: Sagami Bay; June 6, 1958.

Body elongate, 1.8 mm long, 0.42 mm broad at level of acetabulum; forebody abruptly tapered, but hindbody gradually tapered, both with blunt extremities, scattered all over with cuticular papillae as in *Opegaster apogonichthydis* YAMAGUTI, 1938. Cervical glands well developed. Oral sucker subterminal, 0.11×0.145 mm, followed by very short prepharynx; pharynx 0.05×0.055 mm, esophagus 40μ long. Ceca uniting posteriorly; anus ventral, about 85μ from posterior tip of body. Acetabulum protuberant, 0.21 mm in diameter, situated at posterior half of anterior third of body, with 6 horn-like projections, three on anterior margin and three on posterior margin.

Testes directly tandem, at posterior half of middle third of body, occupying whole breadth of intercecal field; anterior testis reniform, 0.14×0.2 mm, posterior testis flattened in front, 0.15×0.18 mm. Vesicula seminalis tubular, extending from immediately behind acetabulum into cirrus pouch, describing three turns in front of acetabulum; cirrus pouch 34μ in diameter, enclosing distal end of seminal vesicle, rounded pars prostatica surrounded by prostatic ducts coming from outside cirrus pouch, and ejaculatory duct, extending from ventral side of left cecum to genital pore. Genital pore just left of intestinal bifurcation.

Ovary reniform, 0.11×0.18 mm, a little to right immediately in front of anterior testis, nearly equatorial. The germiduct arising from the depth of the concavity of ovary proceeds obliquely forward ventral to the vitelline reservoir, at the anterior end of which it gives off the Laurer's canal, and after turning back on itself receives the duct from the vitelline reservoir. The Laurer's canal forming a loop immediately anterodextral to the vitelline reservoir runs obliquely along this reservoir and finally after describing another loop opens dorsally in front of the left lobe of the ovary. Uterine coils occupying whole intercecal field between ovary and acetabulum; metraterm well differentiated, running forward alongside seminal vesicle, crossing over cirrus pouch ventrally. Eggs oval, thin-shelled, 50–60×33–36μ. Vitelline follicles extending mostly in extracecal fields, but in posttesticular region they are almost confluent in the median line. On the right side they commence at the level of the anterior end of the acetabulum, but a little more posteriorly on the left. Excretory vesicle reaching to posterior end of ovary; pore terminal.

This species differs from the most closely related *O. apogonichthydis* YAMAGUTI, 1938, in the anterior extent of the vitellaria and smaller egg size, and from *O. pentadactyla* MANTER, 1940, in the marginal tentacular projections of the acetabulum and egg size. In MANTER's species constant "rudimentary vitellaria" are seen in the forebody and the eggs are 46 to 50μ by 26 to 29μ.

ZOOGONIDAE ODHNER, 1911

14. *Deretrema parapriacanthi* n. sp.

(Pl. XXI, Fig. 9)

Habitat: Small intestine of *Parapriacanthus beryciformes* FRANZ.

Material: Two gravid specimens fixed in Schaudinn's solution under cover glass pressure and stained with Heidenhain's hematoxylin.

Locality and date: Sagami Bay; June 6, 1958.

Body elliptical or oblong, with blunt-pointed extremites, 2.1–2.75 mm long by 0.75–1.0 mm broad. Cuticle may be transversely striated, unspined. Oral sucker subterminal, 0.16 mm in diameter, pharynx 41×52μ, esophagus 0.1–0.16 mm long; posterior cecal extent not made out. Acetabulum 0.24–0.26 mm in diameter, just pre-equatorial.

Testes subglobular, 0.16–0.2 mm in diameter, situated symmetrically at posterior end of middle third of body. Cirrus pouch claviform, 0.22–0.26×0.056–0.06 mm, extending transversely from ventral side of left cecum to left margin of body immediately behind level of intestinal bifurcation, containing tubular seminal vesicle, prostatic complex and ejaculatory duct. Genital pore postbifurcal, on slightly notched left edge of body.

Ovary subglobular, wider than long, 0.21×0.33 mm in the type, overlapping acetabulum on its posterodextral border, with transversely elongated seminal receptacle immediately behind. Uterus occupying all available space posterior to intestinal bifurcation, ventral to ovary, testes and dorsal vitelline follicles; metraterm anterodorsal to cirrus pouch; eggs elliptical, thick-shelled, 44–52×23–29μ. Vitelline follicles 8–9 on each side, forming symmetrical lateral clusters between cirrus pouch and equator, a few follicles dorsal to uterus; vitelline reservoir small, behind medial end of ovary. Excretory arms terminating one on each side of esophagus; excretory pore terminal.

This species resembles *D. pooli* ANNEREAUX, 1947, more closely than any other members of the genus not only in general body shape but also in the internal anatomy, but differs distinctly in egg size. In *D. pooli* the eggs are 50–60μ by 30–32μ.

15. *Lepidophyllum canthigastris* sp.

(Pl. XXI, Fig. 12)

Habitat: Urinary bladder of *Canthigaster rivulata* (TEMM. et SCHLEG.)

Material: Two gravid specimens fixed in Schaudinn's solution under a cover slip and stained with Heidenhain's hematoxylin.

Locality and date: Sagami Bay; June 7, 1958.

Body leaflike, 1.5–2.0 mm long, tapered anteriorly and remarkably expanded at hindbody, with a median or submedian notch at posterior extremity. Cuticle thin and smooth. Oral sucker subterminal, 0.11–0.14×0.11–0.17 mm; short prepharynx present; pharynx globular, 70–90μ in diameter; esophagus 90μ long; ceca with irregular outline, especially posteriorly, and terminating in anterior part of posterior half of body just medial to vitellaria, distended with amorphous ingesta containing dark pigment granules. Acetabulum 0.2–0.32×0.19–0.3 mm, just pre-equatorial.

Testes deeply lobed, especially on outer side, 0.24–0.3×0.12–0.25 mm, situated symmetrically at junction of middle with posterior third of body, immediately behind vitellaria. Vas efferens arising from dorsal side of anterior part of each testis unites with its fellow on ventral side of anterior end of ovary; vas deferens running straight forward dorsal to acetabulum. Cirrus pouch cylindrical, 0.4–0.45×0.035–0.04 mm, extending obliquely from in front of acetabulum toward left margin of body, containing seminal vesicle, prostatic complex and ductus ejaculatorius, the distal end of which is seen everted in both specimens. Genital pore close to left body margin at level of posterior end of pharynx.

Ovary lemon-shaped, 0.08–0.1×0.1–0.12 mm, median, postacetabular, between two cecal ends. The germiduct originating from the ventral side of the ovary proceeds backward and becomes slightly expanded at the point where the Laurer's canal is given off, and then unites with the common vitelline duct coming from behind. Uterus convoluted in inter- and posttesticular region; metraterm running along cirrus pouch on its medial side and opening outside just in front of cirrus. Eggs elliptical, 26–44×15–25μ. Vitellaria forming symmetrical bunches of about 10 follicles each just lateral to cecal ends; vitelline ducts joining together behind ovary; unpaired vitelline duct hook-shaped, with its distal end turned back on itself. Excretory vesicle tubular, short; pore terminal.

This species differs from *L. steenstrupi* ODHNER, 1902, from the urinary bladder of *Anarrhichas minor* s. *pantherinus* from Iceland, in the smooth body, in the acetabulum being definitely larger than the oral sucker, in the anterior position of the genital pore, in the vitellaria being lateral to the ceca, in the seminal receptacle being greatly reduced, etc., and from *L. armatum* ZHUKOV, 1957, in the smooth cuticle, the sucker ratio and the position of the genital pore. In the latter two respects as well as in the position of the vitellaria relative to the ceca it differs also from *L. brachycladium* ZHUKOV, 1957, and *L. pleuronectini* ZHUKOV, 1957.

MONORCHIIDAE ODHNER, 1911

16. *Allolasiotocus nibeae* n. g., n. sp.

(Pl. XX, Fig. 8)

Habitat: Small intestine of *Nibea schlegeli* (BLEEKER).

Material: 10 gravid specimens fixed in Schaudinn's solution under cover glass pressure, stained and mounted as usual.

Locality and date: Sagami Bay; June 6, 1958.

Body fusiform, with blunt-pointed extremities, 1.1–1.6 mm long by 0.55–0.75 mm, 2.4×1.0 mm in a strongly flattened syntype[1], broadest at preacetabular level. Cuticle thin, beset all over with very fine scale-like spines. Oral sucker subterminal, 0.13–0.16 ×0.14–0.17 mm; pharynx small, $45–65 \times 40–63 \mu$; esophagus 0.025–0.1 mm long; ceca terminating close to lateral margins at anterior end of caudal third of body. Acetabulum weakly muscular, 0.08–0.11 mm in diameter, situated at junction of anterior with middle third of body.

Testes single, subglobular, 0.18–0.25 mm in greater diameter, median, in middle third of body. Vesicula seminalis externa oval, 0.11–0.14 mm in diameter, overlapping ovary to right of median line. Cirrus pouch voluminous, 0.2–0.26×0.14–0.16 mm, situated transversely or obliquely immediately behind intestinal bifurcation, containing rounded internal seminal vesicle 0.11–0.14 mm in diameter and well developed prostatic complex; the ejaculatory duct opens directly into the genital atrium which consists of three chambers covered inside with long bristles, and opens ventrally by a large round aperture slightly to left of median line nearly halfway between intestinal bifurcation and acetabulum.

It is interesting to note that the cirrus is represented by the widest right chamber of the genital atrium and the female terminal organ by the left chamber.

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1) Measurements of internal organs in this specimen are not given owing to artificial exaggeration.

Ovary irregularly indented or lobed, 0.15–0.17×0.12–0.17 mm, situated medial to right cecum just anterodextral to testis, the germiduct arising from the dorsal surface of the ovary forms a small bulbous dilatation near its origin and gives off Laurer's canal before joining the common vitelline duct. No seminal receptacle. Laurer's canal short, straight, opening almost middorsally behind acetabulum. Uterus strongly convoluted, occupying all available space of body behind cirrus pouch; metraterm represented by median posterior chamber of genital atrium; eggs oval, thick-shelled, 18–20 ×14–17μ. Vitellaria forming symmetrical bunches of large follicles in shoulder region, 6–9 follicles on each side; paired vitelline ducts joining together close to dorsal cuticle medial to ovary. Excretory vesicle was unable to make out.

In general internal anatomy this genus agrees with *Lasiotocus* LOOSS, 1907, only differing in having an external seminal vesicle and in the cirrus being represented by the widest right chamber of the genital atrium.

Allolasiotocus n. g.

Generic diagnosis.—Monorchiidae: Body small fusiform, spinose. Oral sucker subterminal, pharynx small, esophagus short, ceca not reaching posterior extremity. Acetabulum weakly muscular, well apart from anterior extremity. Testes single, postacetabular. External seminal vesicle present. Cirrus pouch postbifurcal, enclosing large internal seminal vesicle and well developed prostatic complex. Genital atrium consisting of three (right left and median) chambers densely lined with long bristles, opening ventrally out of median line posterior to intestinal bifurcation; right chamber corresponding to cirrus, left chamber to female terminal organ, and median posterior chamber to metraterm. Genital pore wide, submedian, postbifurcal, preacetabular. Ovary dextral, at acetabular or postacetabular level. No seminal receptacle, Laurer's canal present. Uterus strongly convoluted and occupying most of body posterior to genital pore: eggs numerous, thick-shelled. Vitelline follicles massed in symmetrical bunches in shoulder region. Excretory vesicle? Parasitic in intestine of marine teleosts.

Genotype: *A. nibeae* n. sp.

OPISTHOLEBETIDAE FUKUI, 1929

17. *Pseudoheterolebes cotylophorus* (OZAKI, 1935) n. comb.

Habitat: Small intestine of *Chilomycterus affinis* GÜNTHER.

Material: 9 gravid specimens fixed under cover glass pressure in Schaudinn's solution with acetic acid added.

Locality and date: Aquarium of Seto Marine Biological Laboratory, Shirahama; April 5, 1958.

The following measurements are somewhat exaggerated owing to cover glass pressure.

Body 2.1–2.8 mm long by 2.3–2.8 mm wide, prominent at anterior end, convex laterally, truncate and frilled or corrugated at posterior extremity. Oral sucker globular, 0.2–0.3×0.3–0.42 mm, followed by a ring of circular muscle fibers. Pharynx ring-shaped, 0.17–0.22×0.26–0.38 mm. Acetabulum 0.5–0.68×0.56–0.73 mm, postequatorial or posterior according to the technique employed; circumacetabular fold very conspicuous, with puckered margin. Testes 0.2–0.3×0.27–0.38 mm, symmetrical or subsymmetrical, usually overlapping acetabulum at different levels in different individuals. Exceptionally the two testes may overlap the acetabulum diagonally on its anterosinistral border, the anterior one being exactly opposite the ovary. Such a great individual variability in relative position of the testes and ovary is partly due to the cover glass pressure applied to the acetabulum, by which the testes may be pushed either backward or forward ; the ovarian complex, however, is not affected substantially and lies always anterior or anterodorsal to the acetabulum on the right of the median line. Cirrus pouch fusiform, 0.28–0.5×0.08–0.125 mm ; seminal vesicle convoluted and occupying greater posterior part of cirrus pouch. A small pars prostatica is differentiated at the anterior end of the attenuated distal portion of the seminal vesicle ; ductus ejaculatorius narrow and straight. Genital pore median, at intestinal bifurcation or immediately behind it.

Ovary bean-shaped, 0.16–0.2×0.22–0.34 mm, anterodorsal or anterior to acetabulum ; seminal receptacle retort-shaped, immediately preovarian, 0.12–0.17 mm wide. Laurer's canal opening middorsally at level of ovary. Uterine coils confined to left intercecal area opposite ovary and cirrus pouch anterior to acetabulum or testes ; receptaculum seminis uterinum may be conspicuous occasionally. Eggs ovoid, thin-shelled, 78–86×46–62μ. Vitellaria extending in broad lateral fields from level of oral sucker or prepharynx to cecal ends, leaving median and postcecal fields free ; some follicles may extend medially over the intestinal bifurcation.

Because of the presence of a conspicuous circumacetabular fold this species should be separated from *Heterolebes* species lacking this fold. Hence a new genus *Pseudoheterolebes* is proposed, with present species as type. In the type of *Opistholebes* (*O. amplicoelus* NICOLL, 1915), *O. elongatus* OZAKI, 1937, and *O. adcotylophorus* MANTER, 1947, there is no circumacetabular fold.

Pseudoheterolebes n. g.

Generic diagnosis.—Heterolebetidae : Body discoid, truncate and frilled at posterior extremity. Oral sucker subterminal, with well developed postoral ring, prepharynx longer than esophagus, pharynx ring-shaped. Ceca arcuate, terminating near posterior extremity. Acetabulum postequatorial or posterior, surrounded by collar with puckered margin. Testes rounded or oval, symmetrical or subsymmetrical, more or less overlapping acetabulum, may be pre- or postacetabular. Cirrus pouch fusiform or claviform, containing convoluted seminal vesicle, small pars prostatica surrounded by prostatic cells and straight ejaculatory duct. Male genital pore opening midventrally alongside uterine pore or by a common aperture at intestinal bifurcation or immediately behind it. Ovary anterior or anterodorsal to acetabulum on the right of median line. Seminal receptacle immediately preovarion. Laurer's canal present. Uterine coils pretesticular, opposite ovary and cirrus pouch ; eggs moderately large, thin-shelled. Vitelline follicles circumcecal, commencing at level of oral sucker or pharynx. Excretory vesicle ? Parasitic in intestine of marine teleosts.

Genotpye: *P. cotylophorus* (OZAKI, 1935) n. comb., syn. *Heterolebes cotylophorus* OZAKI, 1935
Other species: *P. chilomycteri* n. sp.

18. *Pseudoheterolebes chilomycteri* n. sp.

(Pl. XXI, Fig. 13)

Habitat: Small intestine of *Chilomycterus affinis* GÜNTHER.

Material: Two gravid specimens fixed in Schaudinn's solution under a cover slip, stained and mounted as usual, 2.6–3.0×2.5–2.8 mm.

Locality and date: Aquarium of Seto Marine Biological Laboratory, Shirahama; April 5, 1958.

Body discoid, more or less truncated and frilled or corrugated at posterior end, with median notch. Cuticle smooth. A pair of flat papillae at level of anterior end of oral sucker. The anterior extremity filled with sticky glands projects beyond the oral sucker in form of a flattened cone, at the apex of which there are three (a median and two lateral) openings of the gland ducts. A pair of dorsolateral gland ducts appears to open ventrally on the oral aperture. Oral sucker rounded rectangular, 0.22–0.3×0.37–0.4 mm, subterminal, surmounted by above mentioned glandular preoral lobe, followed by strongly developed postoral ring, which surrounds the prepharynx about 0.1 mm long. Pharynx ring-shaped, 0.2–0.23×0.34–0.35 mm. Esophagus very short; ceca wide, arcuate, terminating blindly at posterior extremity, wide apart from each other. Acetabulum 0.6–0.66 mm in diameter, situated just behind middle of body, provided with an irregular fold of cuticle which does not surround the acetabulum in a continuous circle, the postacetabular fold merging into the posterior frill of the body. On each side of the acetabulum there are strong radial muscle fibers attached to this sucker.

Testes oval, symmetrical, immediately postacetabular, with their long axes divergent, measuring 0.35–0.4×0.27–0.3 mm. Cirrus pouch claviform, 0.54–0.6×0.12–0.14 mm, with its base overlapping acetabulum; seminal vesicle tubular, convoluted, occupying greater swollen portion of cirrus pouch; pars prostatica not distinctly differentiated; ductus ejaculatorius straight and narrow, opening alongside metraterm in a shallow pit, 0.12 mm behind pharynx in the type.

Ovary oval, 0.26–0.3×0.2 mm, overlapping right testis on its mediodorsal side. The germiduct arising from near the middle of the anteromedial margin of the ovary becomes dilated and turns back on itself to join the seminal receptacle and then proceeds anteromesad to receive the vitelline duct dorsal to the posterosinistral margin of the acetabulum. Receptaculum seminis elongate, lying alongside ovary, joining germiduct on anterior surface near its proximal end, its tapering distal portion describing an S-shaped turn mediodorsal to left testis and continued into straight Laurer's canal, which opens outside dorsal to the dextroposterior margin of the acetabulum. After forming a loop dorsal to the left testis the uterus runs forward windingly on the left side of the acetabulum and cirrus pouch; metraterm with well developed circular muscle fibers, opening outside beside ejaculatory duct in a shallow pit. Eggs oval, 78–96×54–63μ, with a knob close to its antiopercular pole. Vitelline follicles comparatively small, extending in lateral fields from beside oral sucker and pharynx to posttesticular area, almost confluent across median line dorsal to intestinal bifurcation. Excretory system not worked out.

This species resembles *P. cotylophorus* (OZAKI, 1935) in body shape but differs from it in the ovarian complex being situated behind the acetabulum between and dorsal to the testes. In *P. cotylophorus* the testes may lie symmetrically just behind the acetabulum, but even in this case the ovary is far anterior to the testes and never comes to lie between the latter.

SCLERODISTOMIDAE DOLLFUS, 1932

19. *Sclerodistomum diodontis* YAMAGUTI, 1942

11 gravid specimens of this species were found in the stomach of *Diodon holoacanthus* which died in the Aquarium of the Seto Marine Biological Laboratory, Kyoto University. As fixed in Schaudinn's solution under strong cover glass pressure, stained and mounted, they gave the following measurements in mm.

Body 6.6–10.3×2.8–4.5; oral sucker 0.55–0.8×0.67–1.0; pharynx 0.2–0.35×0.26–0.4; acetabulum 1.2–2.0 across; testes 0.35–0.55×0.45–0.8; genital cone 0.4–0.7×0.13–0.2; ovary 0.2–0.6×0.4–0.7; eggs 0.03–0.036×0.021–0.026.

DIDYMOZOIDAE POCHE, 1907

20. *Allodidymozoon sphyraenae* n. g., n. sp.

(Pl. XXI, Figs. 14–15)

Habitat: Submucosa of palate of *Sphyraena pinguis* GÜNTHER.

Material: 13 young and full-grown specimens, flattened under cover glass pressure after the eggs had been dissected out of the distended uterus in the grown-up specimens, fixed in Schaudinn's solution, stained with Delafield's hematoxylin except 4, which were stained with Heidenhain's hematoxylin.

Locality and date: Sagami Bay; June 7, 1958.

In the full-grown cysts the two individuals which are almost equal in size were seen spirally coiled together by their hindbodies with the forebodies tuckled in between, but in one cyst there were three individuals of different size; the cyst membrane is so thin and delicate that it can easily be overlooked.

Forebody slender, filiform, 0.7–0.9 mm long (unusually long in one specimen), with slight dilatation (0.1–.013 mm wide) in esophageal region and very fine transverse striations, attached to hindbody near one end of hindbody where the testes are located.

Hindbody spirally twisted, wtth rounded ends, 2.2 6.8 mm long, covered with thin smooth cuticle.

Mouth terminal, opening at tip of prominent apical cone; oral sucker elongate pyriform, 31 41×18-23μ, directly followed by subglobular pharynx 15-20μ in diameter. Esophagus very long and narrow, straight anteriorly but irregularly winding for the greater posterior part; ceca narrow and winding in forebody, but as they enter the hindbody they become gradually wider and finally terminate at the posterior extremity, where they are nearly half as wide as the body itself. No acetabulum.

Testes tubular, long, 0.25-1.0 mm long, situated parallel to each other near base of forebody in anterior part of hindbody, with their blunt ends directed anteriorly. Vas deferens distended with spermatozoa, ascending windingly dorsal to uterus, opening midventrally together with opening of metraterm.

Ovary divided near its proximal end into three slender tubular branches, of which two extend forward along the convex side of the hindbody, one reaching to near the anterior end of the hindbody but the other terminating almost halfway up; the remaining backwardly directed branch gives off on the convex side a comparatively short convoluted branch near its origin, and then another branch a short way down, and finally terminates near the convex side of the posterior extremity; hence there are 5 terminal branches in all in the type specimen; in other specimens the number of the terminal ovarian branches was unable to determine. The sigmoid main trunk of the ovary, which lies near the convex side of the postequatorial region of the hindbody, gradually tapers as it proceeds toward the shell gland, in which the germiduct joins the common vitelline duct. There is neither seminal receptacle nor Laurer's canal. The narrow greater proximal portion of the uterus is confined to the peripheral area of the hindbody, while the wider distal portion distended with eggs occupies the central area; before entering the forebody the uterus forms a very wide cylindrical reservoir lying in the central axis of the hindbody as in other didymozoids; at the base of the forebody, however, it tapers again into a winding tube running forward in the intercecal field of the forebody; after crossing the intestinal bifurcation it comes to lie ventral or ventrolateral to the esophagus; the terminal portion of the uterus is differentiated into a straight median duct which is lined with cuticular leaflets and tapers markedly before opening midventrally just behind the apical mouth aperture. Eggs bean-shaped, 13-16×7-8μ. The common vitelline duct, comparatively narrow (36μ wide in the type) and sigmoid, is divided into two main trunks, of which the anterior is subdivided into four branches and the posterior into five branches; all the branches, extending along the convex side of the hindbody like the ovarian branches, terminate near the cuticle at different levels, the longest anterior branch reaches the anterior extremity and the four posterior branches terminate at the posterior extremity. Excretory system not worked out.

This species bears a certain resemblance to *Didymozoon spirale* YAMAGTI, 1938, from the submucosa of the buccal cavity of *Platycephalus indicus*, but differs from it fundamentally in the internal anatomy; in *Didymozoon* as well as in *Didymocystis* the shell gland complex lies at or near the level of the proximal ends of the testes, anterior to the midregion of the hindbody, whereas in the present genus it is far removed from the testes, and the seminal receptacle is absent contrary to *Didymozoon* and *Didymocystis*. Furthermore, the female reproductive organs do not extend into the testicular region in *Didymozoon*, to which the present genus is more related in general body shape than to any other genera.

Allodidymozoon n. g.

Generic diagnosis.—Didymozoidae: Encysted in pairs, with hindbodies coiled together and forebodies tuckled in between. Forebody slender, somewhat expanded in esophageal region, attached to hindbody near its anterior extremity; hindbody cylindrical, spirally twisted, with rounded ends. Oral sucker very prominent, pyriform, directly followed by pharynx; esophagus long, winding; ceca inflated in hindbody, especially at its posterior extremity. No acetabulum. Testes tubular, parallel to each other, in anterior part of hindbody. Vas deferens in forebody, apparently opening together with opening of metraterm. Ovary tubular, branched, extending near convex side of hindbody throughout its length; shell gland situated far back of testes near convex side; seminal receptacle absent. Vitellaria tubular, branched, extending near convex side of hindbody throughout its length. Greater proximal portion of uterus convoluted in peripheral area of hindbody, distal inflated portion occupying most of central area of hindbody, tapering as it enters forebody and running in median field of latter; metraterm lined with cuticular leaflets, opening midventrally very close to apical mouth aperture; eggs bean-shaped, small. Excretory vesicle ? Parasitic in submucosa of buccal cavity of marine teleosts.

Genotype: *A. sphyraenae* n. sp.

Acknowledgements

I am greatly indebted to the Enoshima Aquarium ar Katase, Kanagawa Prefecture, the Seto Marine Biological Laboratory of Kyoto University, and Tamano Marine Laboratory of Okayama University for their generous supply of laboratory facilities and fish materials from which the parasites described here were collected.

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EXPLANATION OF PLATES XX-XXI

PLATE XX

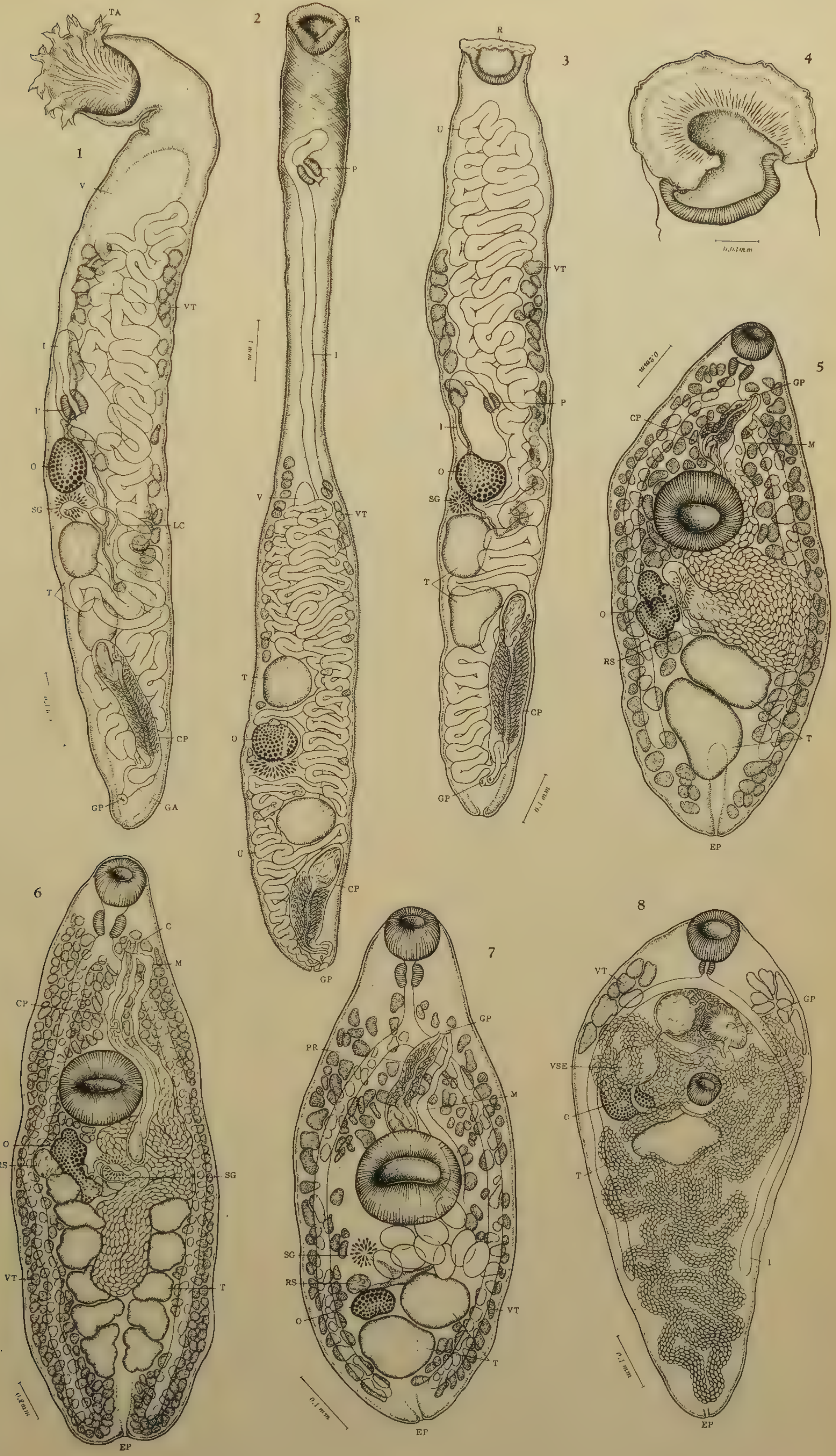
Fig. 1. *Bucephalus sebastichthydis* n. sp., ventral view.
Fig. 2. *Dolichoenterum magnum* n. sp., ventral view.
Fig. 3. *Rhipidocotyle sphyraenae* n. sp., ventral view.
Fig. 4. Rhynchus of *Rhipidocotyle sphyraenae*, ventral view.
Fig. 5. *Plagioporus* (*Caudotestis*) *parapercis* n. sp., ventral view.
Fig. 6. *Decemtestis parapercis* n. sp., ventral view.
Fig. 7. *Plagioporus* (*Plagioporus*) *kyusen* n. sp., ventral view.
Fig. 8. *Allolasiotocus nibeae* n. g., n. sp., ventral view.

PLATE XXI

Fig. 9. *Deretrema parapriacanthi* n. sp., ventral view.
Fig. 10. *Opegaster elongata* n. sp., ventral view.
Fig. 11. *Maculifer chilomycteri* n. sp., ventral view.
Fig. 12. *Lepidophyllum canthigastris* n. sp., ventral view.
Fig. 13. *Pseudoheterolebes chilomycteri* n. sp., ventral view.
Fig. 14. *Allodidymozoon sphyraenae* n. sp., ventral view. Uterus in hindbody omitted.
Fig. 15. Anterior extremity of forebody of *Allodidymozoon sphyraenae*, ventral view.

ABBREVIATIONS USED IN FIGURES

AC=acetabular collar, AN=anus, C=cirrus, CP=cirrus pouch, D=vas deferens, E=esophagus, EP=excretory pore, F=forebody, GA=genital atrium, GP=genital pore, I=intestine, LC=Laurer's canal, M=metraterm, MT=mouth, N=nerve commissure, O=ovary, P=pharynx, PO=postoral ring, PR=prostatic cell, R=rhynchus, RS=receptaculum seminis, SG=shell gland, T=testis, TA=tentacular appendage, U=uterus, V=excretory vesicle, VR=vitelline reservoir, VT=vitellaria.



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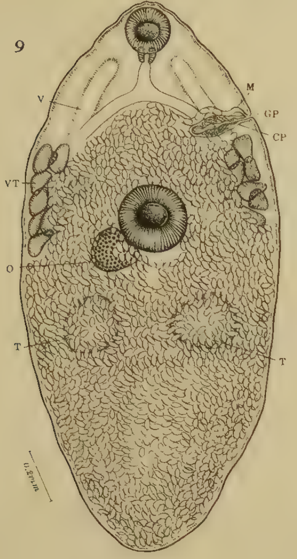

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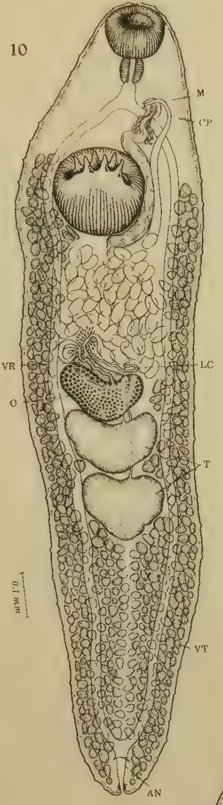

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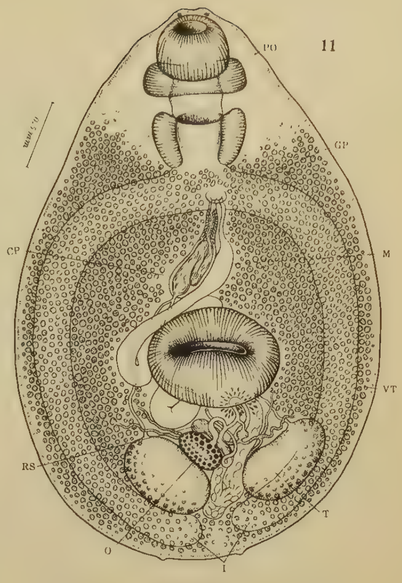

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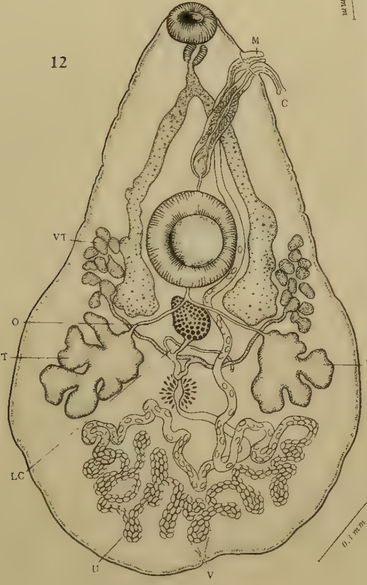

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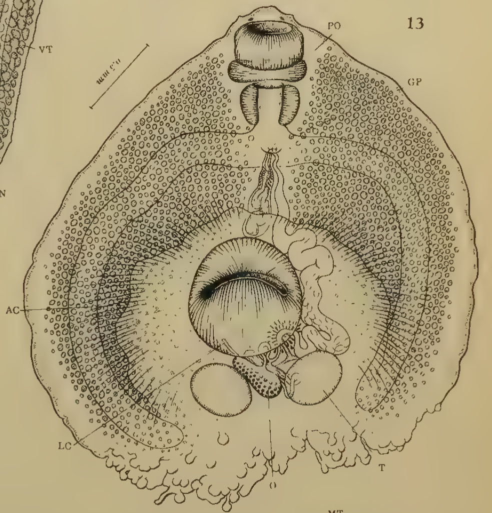

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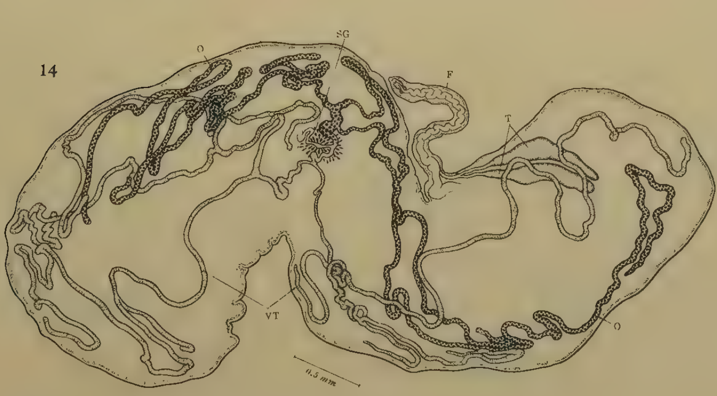

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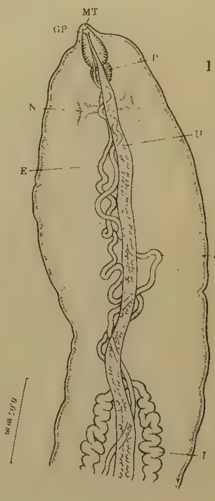

S. YAMAGUTI: STUDIES ON THE HELMINTH FAUNA OF JAPAN, 54.

NOTES ON FIVE SPECIES OF THE AMPHIPOD GENUS *AMPELISCA* FROM THE STOMACH CONTENTS OF THE TRIGLID FISHES

Kizô NAGATA

Naikai Regional Fisheries Research Laboratory

With 11 Text-figures

It is well known that the amphipods are often found abundantly in the stomach contents of various benthos feeders as prey-animals. The amphipod genus *Ampelisca* is one of the most important inhabitants on every marine soft bottom deeper than low tide marks and is also commonly found in the stomach contents of fishes caught in the Seto Inland-sea, Japan.

I had now an opportunity to observe the stomach contents of benthos-feeding fishes taken by the experimental two-boat trawlers which cruised over eleven "Nada" areas around the coast of Shikoku Island.

The materials here dealt with have been obtained only from the fishes belonging to the family Triglidae in the catches of the five times cruises carried on from September 1957 to August 1958. The amphipod genus *Ampelisca* was found in the following six species of this family: 1) *Pachytrigla alata* (HOUTTUYN), 2) *Lepidotrigla japonica* (BLEEKER), 3) *L. güntheri* HILGENDORF, 4) *L. abyssalis* JORDAN et STARKS, 5) *L. kishinouyi* SNYDER and 6) *L. microptera* GÜNTHER.

The stations for the experimental fishing are all on the continental shelf: 20–60 metres depth in inner areas, 60–130 metres depth in outer areas along the Pacific coast of Shikoku.

Marine Gammaridean amphipods from the coasts of Japan and its adjacent waters have been reported by STEBBING (1888), STEPHENSEN (1932, 1944), BULYCHEVA (1936), IWASA (1939, 1957), DAHL (1945), etc., but there are only a few records on the genus *Ampelisca*.

DAHL described in 1945 three species (*A. brevicornis*, *A. bocki* n. sp., *A. misakiensis* n. sp.) from the Pacific coast of Japan, mainly Sagami Bay. BULCHEVA reported in 1936 on two new species (*A. furcigera* n. sp., *A. birulai* n. sp.) from the Japan Sea. And then IWASA described in 1957 two species (*A. diadema*, *A. zamboangae*) briefly with some figures from the seas of Kyûshû, Ryûkyû Islands and Formosa.

The present report comprises five species of which three seem to be new ones.

Publ. Seto Mar. Biol. Lab., VII (2), 1959. (Article 13)

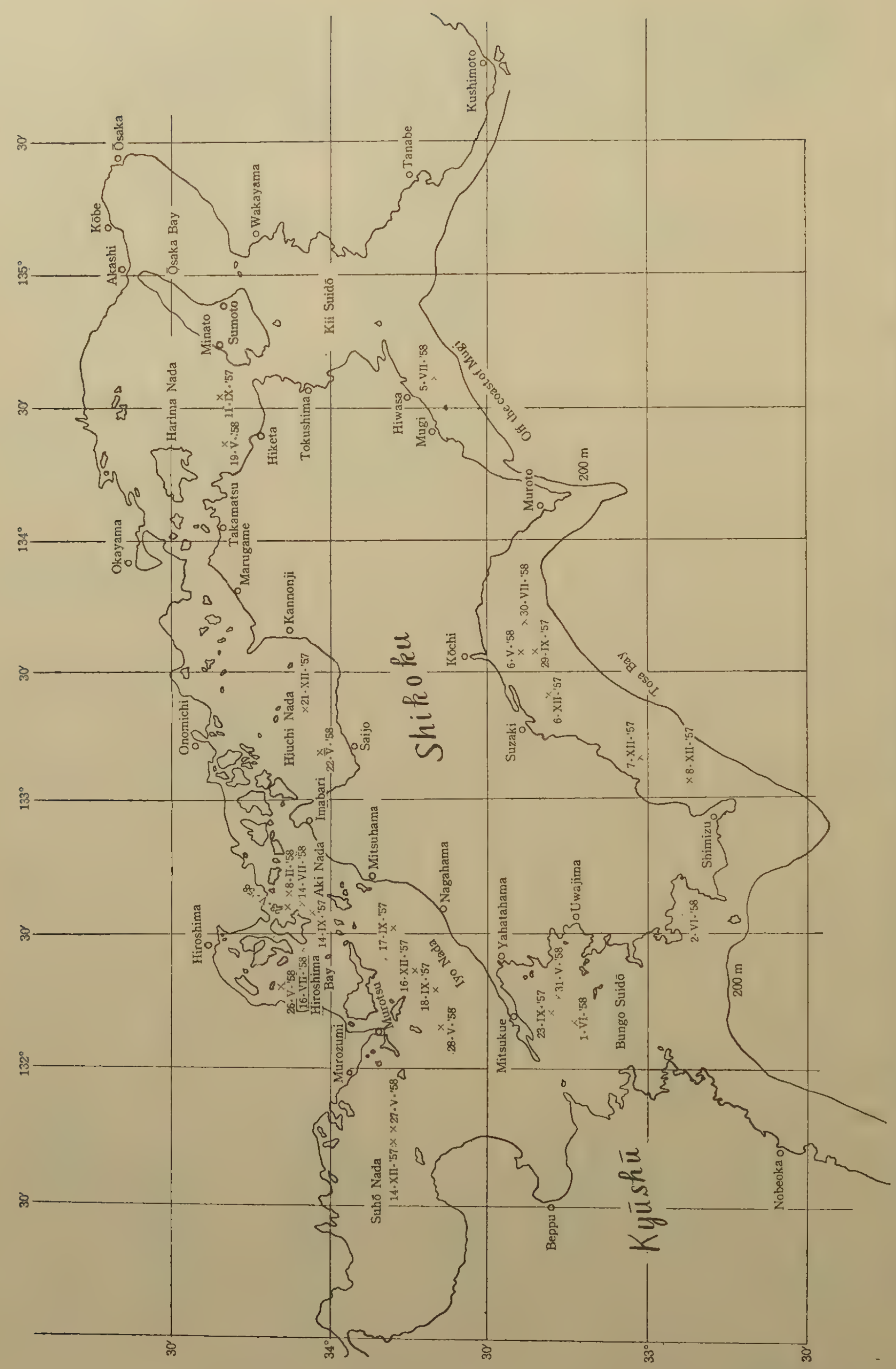

Fig. 1. Chart showing the location of stations (×), where triglid fishes containing the amphipod genus *Ampelisca* in the stomach contents were captured by the experimental two-boat trawlers from September 1957 to August 1958.

I wish to acknowledge the opportunity and aid given by Dr. T. HANAOKA, chief of the Naikai Regional Fisheries Research Laboratory for this study and preparing this paper and for offering the available materials collected by the staff of the Laboratory. I am deeply indebted to Dr. H. UTINOMI of the Seto Marine Biological Laboratory, Kyoto University, for his constant guidance and many valuable advices throughout the course of this work. My thanks are also due to Dr. S. MIYAKE of Kyushu University for his advices and offering the reprints useful to my work.

Ampelisca brevicornis (A. COSTA)

(Fig. 2)

SARS, 1891, p. 169, pl. 59, fig. 1 (*laevigata*).
STEBBING, 1906, p. 100.
CHEVREUX et FAGE, 1925, p. 74, fig. 69.
BARNARD, 1932, p. 84.
PIRLOT, 1936, p. 277.
BARNARD, 1937, p. 148.
DAHL, 1945, p. 9, fig. 8 (cf. *brevicornis*).

Occurrence:

		From stomach of					
'Nada'-area	Date	*L. microptera*	*L. kishinouyi*	*P. alata*	*L. japonica*	*L. güntheri*	*L. abyssalis*
Tosa Bay	29–9–1957	·	·	·	14	·	·
	6, 7, 8–12–'57	·	·	3	18	·	·
	30–7–'58	·	·	·	9	·	·
Bungo Suidô	23–9–'57	1	·	·	·	·	·
	1, 2–5–'58	2	1	·	1	1	·
Iyo Nada	17, 18–9–'57	3	·	·	·	·	·
	28–5–'58	4	1	·	·	·	·
Suhô Nada	14–12–'35	2	·	·	·	·	·
	27–5–'58	4	2	·	·	·	·
	17–7–'58	3	·	·	·	·	·
Hiroshima Bay	26–5–'58	9	·	·	·	·	·
	14, 16–7–'58	2	·	·	·	·	2
Aki Nada	22, 23–5–'58	6	·	·	·	·	·
Hiuchi Nada	21–12–'57	1	·	·	·	·	·
Harima Nada	19–5–'58	3	·	·	·	·	·

Remarks: Length of specimens up to 12 mm. Lateral lobe of head slowly rounded. Anterodistal corner of article 4 of pereiopod 3 much produced nearly to distal end of article 5; article 7 of pereiopod 3 about 1.5 times as long as 5 and 6 combined. Article 3 of pereiopod 7 subequal in length to article 4 of which back lobe drawn out into a long, broad and rounded corner. Postero-inferior margin of pleon segment 3 somewhat less sinuated than in SARS' and CHEVREUX' figures. Apices of telson and rami of uropod 3 less pointed.

This is known as cosmopolitan species, as reported from N. Atlantic, Mediterranean, the coast of Africa, Indian Ocean, Tropical Pacific and also the coast of Japan, where this species was described by DAHL in 1945 from Kobe Bay.

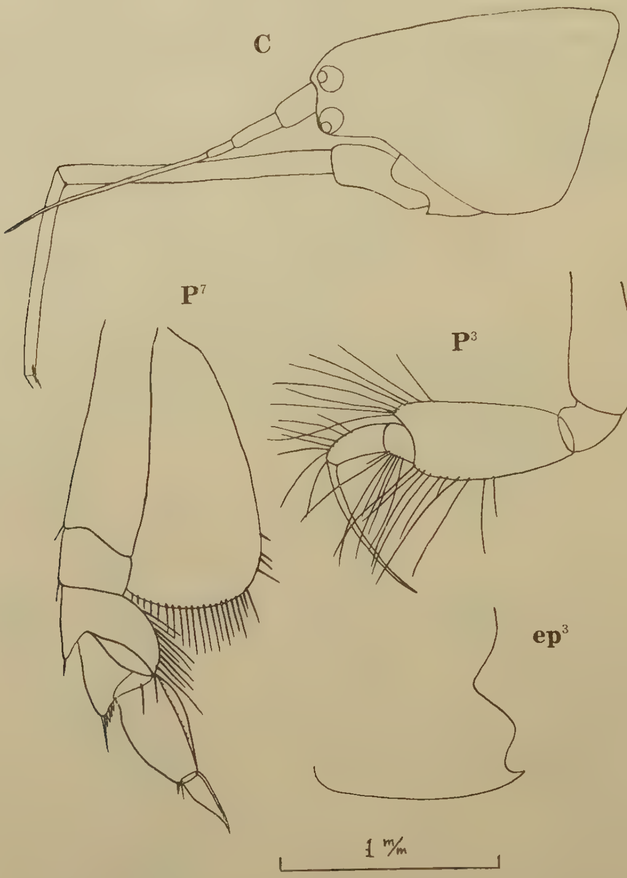

Fig. 2. *Ampelisca brevicornis* (A. COSTA), ovig. female. C, head; d.c., dorsal carina of pleon segments 4–6; ep^3, 3rd epimeral plate (posterior edge of pleon segment 3); P^1–P^2, 1st–2nd pereiopod (gnathopod); P^3–P^7, 3rd–7th pereiopod; t, telson; up^3, 3rd uropod.

Ampelisca miharaensis n. sp.

(Figs. 3–5)

Occurrence:

		From stomach of				
'Nada'-area	Date	*L. microptera*	*L. kishinouyi*	*P. alata*	*L. japonica*	*L. abyssalis*
Tosa Bay	29–9–1957	3	·	·	29	·
	6, 7–12–'57	·	·	3	5	·
	30–7–'58	·	·	·	1	·
Bungo Suidô	2–5–'58	·	1	·	·	1
	22–7–'58	·	1	·	·	·

Desciption of ovigerous female: Length 7 mm. Anterior edge of head strongly incised; lateral lobe conspicuously produced; lower front margin obliquely straight; upper pair of eyes behind antenna 1; lower pair of eyes below lateral angle on the lower front margin.

Antenna 1 a little shorter than antenna 2 (both antennae much setose on confrontal margin); article 2 of peduncle about 1.5 times as long as 1 which is tumid; article 3 of peduncle about one-fourth as long as 2; flagellum 20-jointed.

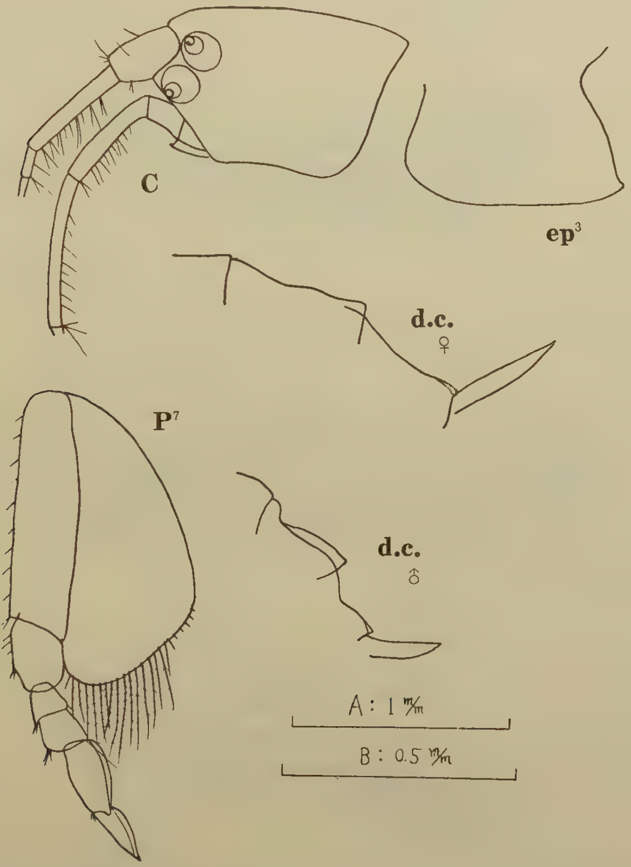

Fig. 3. *Ampelisca miharaensis* n. sp., ovig. female, 7 mm and male 4.5 mm. Legend as before.

A scale: C, d.c., ep^3, up^3, P^3, P^4, and P^7.
B scale: P^1, P^2, and t.

Antenna 2 more than one half times as long as body; article 5 of peduncle longer than 4; flagellum 22-jointed.

Pereiopod 1: article 6 about two-thirds as long as 5; posterior edge of article 6 slightly convex; article 7 about one half as long as 6.

Pereiopod 2: article 6 about one half as long as 5; article 7 one half as long as 6.

Pereiopod 3: anterodistal angle of article 4 almost not produced; article 7 slightly longer than 5 and 6 combined.

Pereiopod 4 more setose than pereiopod 3; anterodistal corner slightly produced; article 7 a little longer than 5 and 6 together.

Pereiopod 5 and 6 without special characteristics.

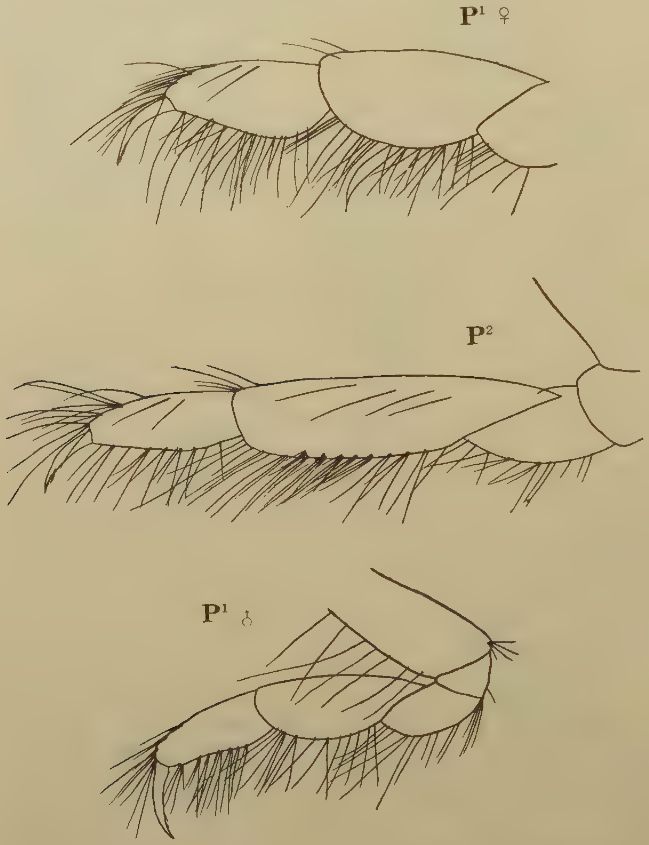

Fig. 4. *Ampelisca miharaensis* n. sp., ovig. female, 7 mm and male, 4.5 mm. Legend as before.

Pereiopod 7: lower hind edge of posterior lobe of article 2 obliquely rounded somewhat straight; its lobe nearly reaching as far as distal end of article 3; article 4 much shorter than 3; article 5 slightly longer than 4; article 6 twice as long as 5; article 7 slightly shorter than 6.

Uropod 1 reaching slightly beyond end of uropod 2; rami subequal in length and also equal to peduncle; outer edge of inner ramus and inner edge of peduncle spinulate respectively.

Uropod 2: rami shorter than peduncle; outer edge of each ramus and each side of peduncle spinulate respectively.

Uropod 3: outer ramus slender, subequal length to the inner ramus which is moderately broad; inner edge of inner ramus with several long setae; both side of outer ramus with many small spines.

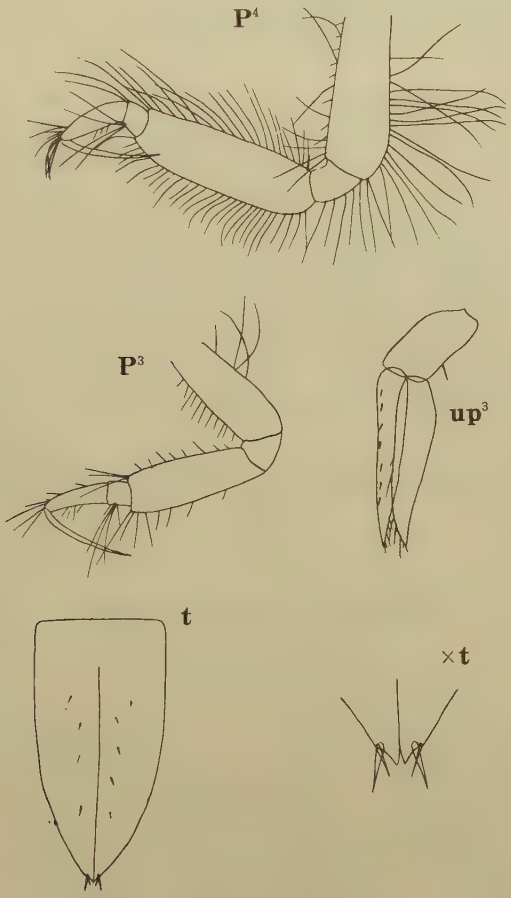

Fig. 5. *Ampelisca miharaensis* n. sp., ovig. female, 7 mm and male, 4.5 mm. Legend as before.

Telson twice as long as broad, tapering to the apex which is pointed and slightly notched; its notch with one spine and one spinule; upper surface of each lobe with several spinules; cleft to about five-sixths of all length.

Pleon segment 3: posterior edge slightly convex; lower hind corner with a small blunt tooth.

Pleon segment 4: dorsal posterior surface not so strongly developed.

Pleon segment 6: lateral ridges with a weak process.

Male 4.5 mm in length. Differing from the female by the setal tufts on the peduncle of antennae, by the length of antenna 2 about equal to body, by the posterior dorsal surface of pleon segment 4 raised into a slightly saddle-shaped process and by the lateral ridges of pleon segment 6 more developed. Particularly, the most characteristic point is the shape of article 6 of pereiopod 1 which is slender and oblong with a shallow convex along posterodistal margin.

Type locality: Mihara Bay, Hiroshima prefecture. Collected by Ekman's grab-sampler.

Remarks: Length of specimens up to 9 mm. The species is similar to *A. serraticaudata* CHEVREUX in the relative proportion of length between 1st and 2nd antennae, the shape of head and posterior lobe of article 2 of pereiopod 7, and hind lower corner of pleon segment 3, but differs in rather shorter dactylus of pereiopod 3 and 4, the length of dactylus of pereiopod 7, the slender form of uropod 3 and the shape of the apex of telson. And also this resembles *A. aequicornis* BRUZEL., but differs in the relative proportion of length of peduncle of antenna 1, the structure of pereiopod 4, the shape of back lobe of article 2 of pereiopod 7 and the length of article 7 of this appendage. From *A. milleri* J. BARNARD it differs in the lack of prominent posterodistal corner of article 5, longer dactylus of pereiopod 7 and the slender uropod 3.

This species is named from Mihara Bay, where a large number of this species were collected in 1955.

Ampelisca naikaiensis n. sp.

(Figs. 6–8)

Occurrence :

		From stomach of		
'Nada'-area	Date	*L. microptera*	*P. alata*	*L. japonica*
Tosa Bay	29–9–1957	·	4	7
	6–5–'58	1	·	·
	30–7–'58	·	·	20
Bungo Suidô	31–5, 2–6–'58	4	·	1
Iyo Nada	17–9–'57	8	·	·
	16–12–'57	1	·	·
	28–5–'58	1	·	·
Suhô Nada	14–12–'57	10	·	·
Aki Nada	14–9–'57	5	·	·
	8–2–'58	2	·	·
	22, 23–5–'58	7	·	·
Hiuchi Nada	22–5–'58	4	·	·
Harima Nada	11–9–'57	2	·	·
Off the coast of Mugi, Tokushima Prefecture	5–7–'58	1	·	·

Description of evigerous female: Length 75 mm. Anterior edge of head slightly incised; lower front margin obliquely, rather straight; upper pair of corneal lenses behind upper edge of antenna 1, lower pair below lateral angle of head.

Antenna 1 reaching beyond end of peduncle of antenna 2; article 2 of peduncle less than twice as long as 1; article 3 shorter than 1; flagellum 7-jointed.

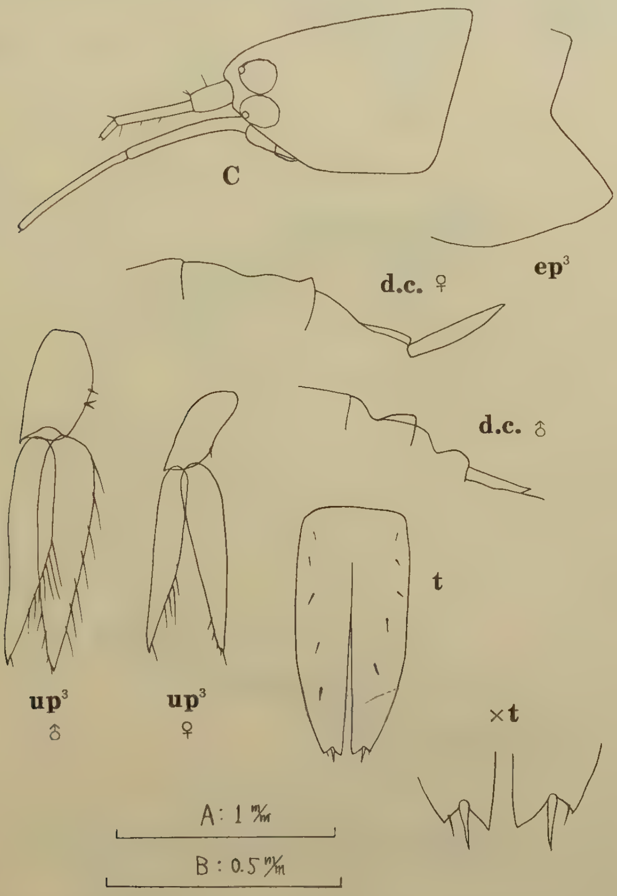

Fig. 6. *Ampelisca naikaiensis* n. sp. ovig. female, 7.5 mm and male, 4.5 mm. Legend as before.

A scale: C, d.c., P^3, P^4, P^7, up^3-female.
B scale: P^1, P^2, t, and up^3-male.

Antenna 2 extending to only a half length of body; article 5 of peduncle slightly longer than 4; flagellum 12-jointed. Both antennae slim and slender.

Pereiopod 1: article 6 oblong, about two-thirds as long as 5; posterior edge slightly concave with a long and strong setal spine; article 7 long, slender, about two-thirds as long as 6.

Pereiopod 2 long and slender; article 5 about 2.5 times as long as 6 which nearly straight at posterior margin; article 7 slightly more than one half as long as article 5.

Pereiopod 3: article 4 rather slender, anterodistal angle almost not produced; article 7 longer than 5 and 6 combined.

Pereiopod 4: article 4 broader than 5 and 6 and more setose than pereiopod 3; its anterodistal corner not produced; article 7 longer than 5 and 6 combined.

Pereiopod 5 and 6 with no special characteristics.

Pereiopod 7: inferior hind margin of back lobe of article 2 rounded, extending to distal end of article 3 which is much longer than 4; article 5 slightly longer than 4; article 6 longer than 7.

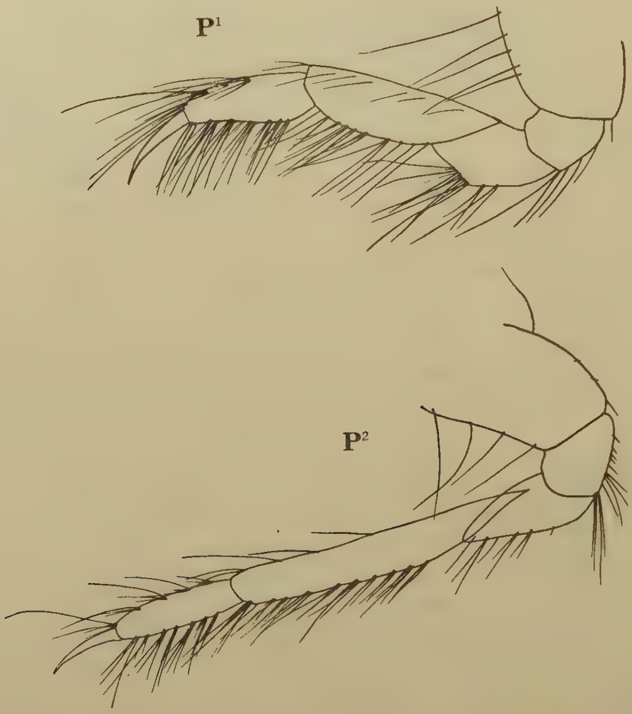

Fig. 7. *Ampelisca naikaiensis* n. sp., ovig. female, 7.5 mm and male, 4.5 mm. Legend as before.

Uropod 1 reaching slightly beyond end of uropod 2; outer ramus a little longer than inner; peduncle and rami almost equal in length; outer edge of inner ramus with some spines.

Uropod 2: rami and peduncle equal in length; inner ramus slightly longer than outer; outer edge of inner ramus with some spines.

Uropod 3: rami subequal in length and slightly setose; outer ramus slightly slender than inner.

Telson more than twice as long as broad, apices strongly notched with one spine and one setule; dorsal surface of each lobe with five spinules; cleft to four-fifths of all length.

Pleon segment 3: posterior edge almost straight; lower hind corner rounded.

Pleon segment 4: posterior dorsal surface raised into a weakly saddle-shaped process.

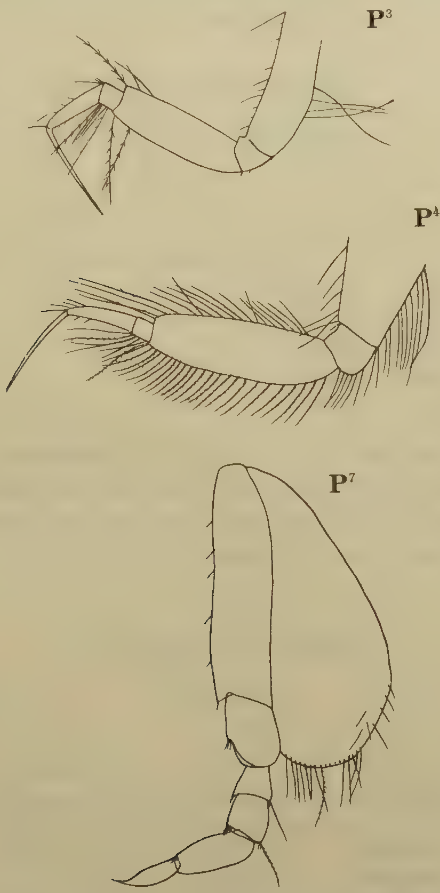

Fig. 8. *Ampelisca naikaiensis* n. sp., ovig. female, 7.5 mm and male, 4.5 mm. Legend as before.

Pleon segment 6: lateral ridges low.

Male 4.5 mm in length. Antenna 2 reaching fully to the end of body; both antennae with the setal tufts on the peduncle; uropod 3 more setose than in female; pleon segment 4 and 6 raised higher than in female into the posterior dorsal surface.

Type locality: Mihara Bay. Collected by Ekman's grab type sampler.

Remarks: This species closely resembles *A. spinimana* CHEVREUX in short antennae, the shape of back lobe of article 2 of pereiopod 7 and the shape of lower hind corner of pleon segment 3, but differs in the structure of pereiopod 1, the length of article 7 of pereiopod 3 and 4, the relative proportion of length of article 6 to 7 of pereiopod 7, the strong notch at apices of telson, and in the shape of uropod 3.

These specimens have length of up to 8 mm. Together with *A. miharaensis*, this species was also collected in Mihara Bay during the same survey, but there were a few in numbers.

Ampelisca bocki DAHL

DAHL, 1945, p. 2, figs. 1–3.

Occurrence:

		From stomach of		
'Nada'-area	Date	*L. microptera*	*L. japonica*	*L. abyssalis*
Tosa Bay	29–9–1957	·	1	·
	30–7–'58	·	2	·
Bungo Suidô	2–5–'58	·	·	1
Suhô Nada	27–5–'58	1	·	·
Aki Nada	22–5–'58	1	·	·

Remarks: These specimens show the entire agreement with DAHL's specimens which was described by DAHL in 1945 from Kobe Bay for the first time. Before this investigations, this species was collected also from Mihara Bay by Ekman's grab. Specimens described above, have the length of up to 11 mm.

Ampelisca iyoensis n. sp.

(Figs. 9–11)

Occurrence:

		From stomach of	
'Nada'-area	Date	*L. microptera*	*L. japonica*
Tosa Bay	29–9–1957	·	1
Bungo Suidô	1–5–'58	1	1
Iyo Nada	17–9–'57	3	·
Aki Nada	23–5–'58	2	·

Description of male: Length 11 mm. Anterior edge of head rounded without any incision; lower front margin parallel to upper margin; only a single lens on each side of head behind anterior edge.

Antenna 1 attached to lower front margin and reaching slightly beyond end of peduncle of antenna 2; second article more than two times as long as first; third article shorter than one half of first; setal tufts typically developed on peduncles of both antennae; flagellum 19-jointed.

Antenna 2 extending to pleon segment 3; article 4 much longer than 5; flagellum 54-jointed.

Pereiopod 1: article 6 with clearly separated palm and about two-thirds as long as 5; article 7 short.

Pereiopod 2: much more slender than pereiopod 1; article 5 about two times as long as 6 which has no apparent palm; article 7 short.

Pereiopod 3: anterodistal corner rather produced; article 7 longer than 5 and 6 combined.

Pereiopod 4: almost similar to 3.

Pereiopod 5 and 6 with no special characteristics.

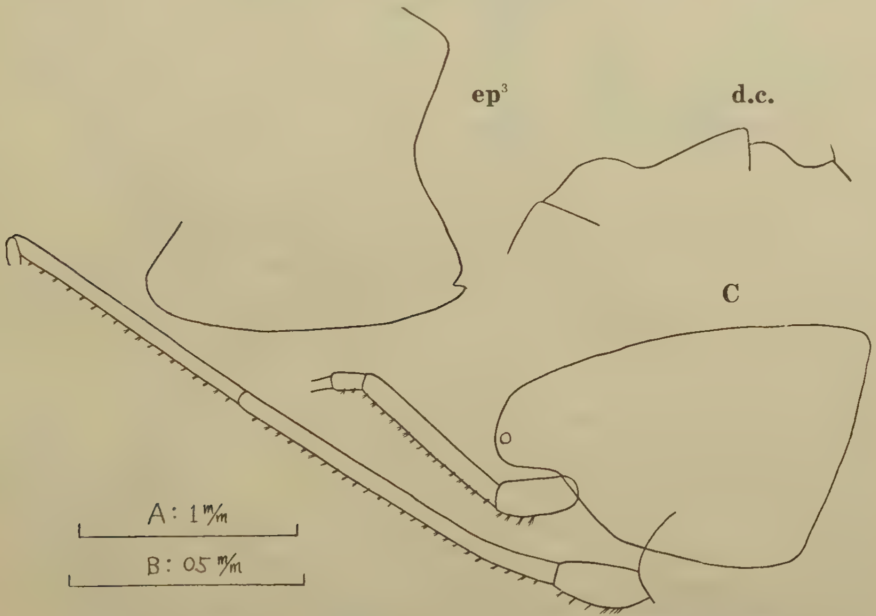

Fig. 9. *Ampelisca iyoensis* n. sp., male, 11 mm. Legend as before.
Scale A: C, d.c., ep^3, P^1, P^2, P^3, P^4, up^3.
Scale B: t.

Pereiopod 7: lower hind margin of back lobe of article 2 rounded, extending to the middle of article 4 which is much shorter than 3; anterodistal corner of article 5 produced; article 6 longer than 4 and 5 combined; article 7 a little shorter than 6.

Uropod 1 not reaching beyond the middle of rami of uropod 2; peduncle slightly longer than rami; outer ramus a little longer than inner; rami slender and smooth except proximal edge of inner ramus, here carrying three small spines.

Uropod 2: peduncle longer than rami; outer ramus shorter than inner; apices of outer and inner ramus with one long spine respectively.

Uropod 3: inner ramus slightly longer than outer; both rami much setose on both sides.

Telson: rather robust, much constricted near base, tapering distally, carrying here a pair of strong notch with two setae and one setule respectively; cleft to one half of its length; upper surface of each lobe with 4–6 setae.

Pleon segment 3: posterior edge slightly convex; lower hind corner with a tooth.

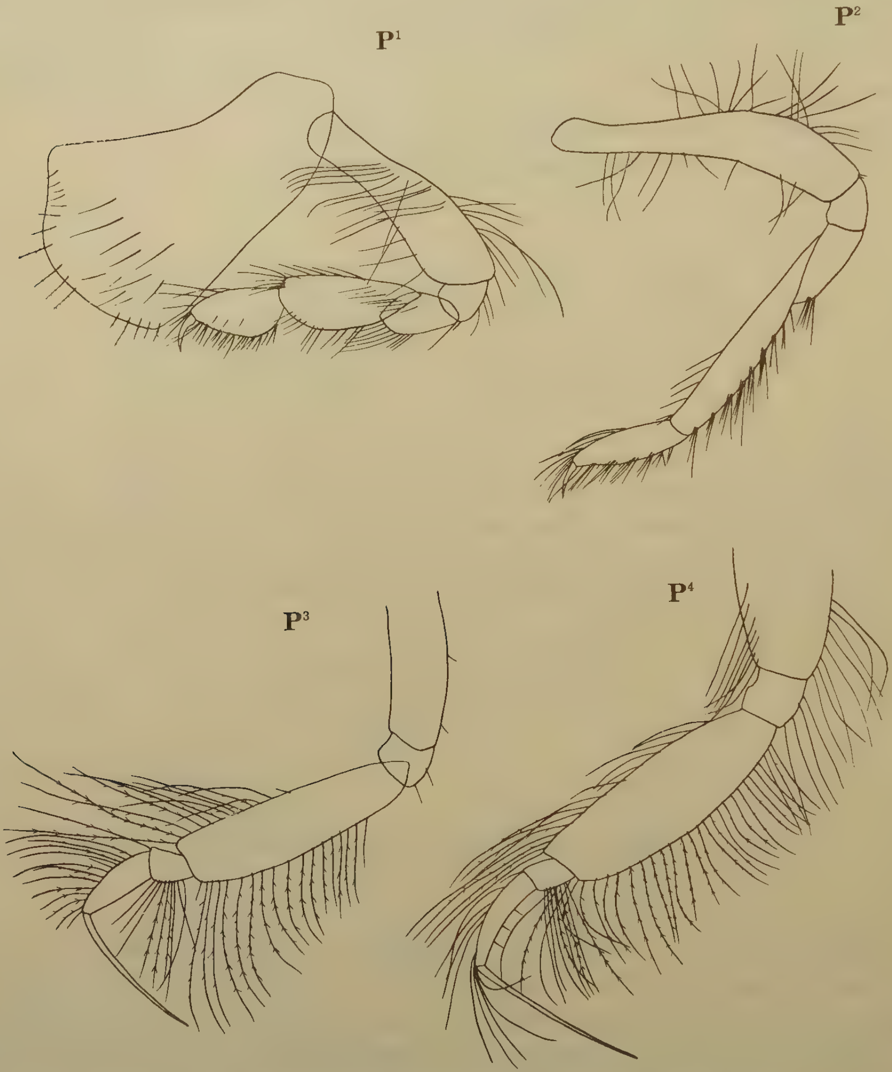

Fig. 10. *Ampelisca iyoensis* n. sp., male, 11 mm. Legend as before.

Pleon segment 4: posterior dorsal surface raised into a subcrestate process.

Pleon segment 6: lateral crest not strongly developed.

Female: without any striking sexual differences, except no setal tufts on peduncles of antennae and relatively shortened ones.

Type locality: Iyo Nada.

Remarks: All specimens are very large, up to 14 mm in length. This species somewhat resembles *A. misakiensis* DAHL in only one pair of lens and the attachment-point of 1st antenna, but differs in the structure of pereiopod 7, the shape of the head, lower hind margin of pleon segment 3, and telson. This species was encountered in the present investigation for the first time.

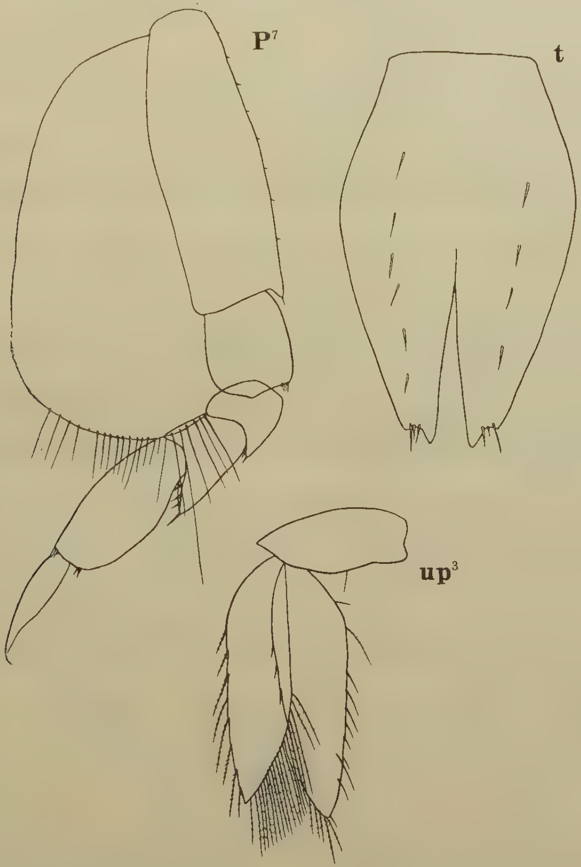

Fig. 11. *Ampelisca iyoensis* n. sp., male, 11 mm. Legend as before.

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THE GENUS *CHELIDONURA* AND A NEW SPECIES, *C. TSURUGENSIS*, FROM JAPAN[1]

KIKŪTARÔ BABA and TAKEO ABE

Biological Laboratory, Osaka Gakugei University;
Takaoka High School, Takaoka, Toyama Pref.

With 2 Text-figures

The following is a list of the species of the genus *Chelidonura* known from the Japanese waters.

1. *Chelidonura hirundinina* (QUOY & GAIMARD, 1832). Nishiki-tsubamegai.
   Loc.: Hayama and Misaki, Sagami Bay; Kii; Okawa, Osaka Bay; Sado I.; Usetsu and Ogi, Toyama Bay; Togi Kazanashi, w. coast of Noto Peninsula; Myojinzaki Mizushima, Tsuruga Bay; Takarajima, Tokara group.
   Dist.: Indian Ocean; Australia; N. Caledonia; Bonin Is.
2. *Chelidonura fulvipunctata* BABA, 1938. Akaboshi-tsubamegai.
   Loc.: Shimoda; Kii.
3. *Chelidonura inornata* BABA, 1949. Ohaguro-tsubamegai.
   Loc.: Hayama, Sagami Bay.
   Dist.: Bonin Is.

The following is here added to the above list.

Chelidonura tsurugensis BABA & ABE, n. sp.

Myojin-tsubamegai (n. n.)

(Figs. 1–2)

Animals 15–20 mm in total length. Mantle-shield bifurcated behind, the left lobe long and tapering, the right one in all specimens shorter and rounded. General body-colour a glossy purplish black. The whole upper surface except the sole is covered with a varying number of yellow or golden-yellow spots, very irregular in size and in arrangement. An opaque white marking at the anterior edge of the head-shield on each side. Parapodial lobes without a coloured border.

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[1] Contributions from the Seto Marine Biological Laboratory, No. 326.

Publ. Seto Mar. Biol. Lab., VII (2), 1959. (Article 14)

Loc.: Myojinzaki Mizushima, Tsuruga Bay, under stones in the shallow water (July 1956, many sps.).

There are about twelve species and two varieties in the genus *Chelidonura* of the world (see MARCUS, 1955, pp. 100-101). Our species comes nearest to *C. hirundinina* (Q. & G.), var. *punctata* ELIOT from Zanzibar, but the latter form is especially marked by large, well-defined, orange spots rather regularly set on the body (see ELIOT, 1903, p. 336, pl. 13, fig. 2). Also our species cannot be confounded with *C. fulvipunctata* BABA in the detail of colouring.

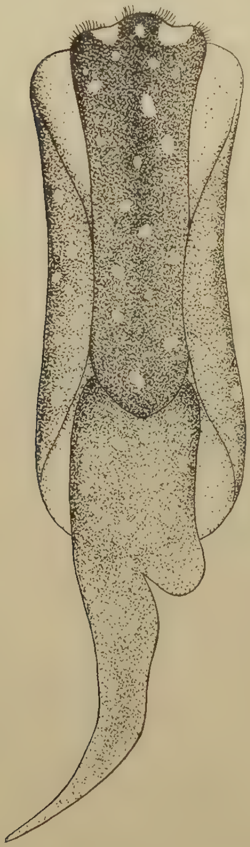

Fig. 1. *Chelidonura tsurugensis* (Tsuruga Bay, July 30, 1956, total length 20 mm).

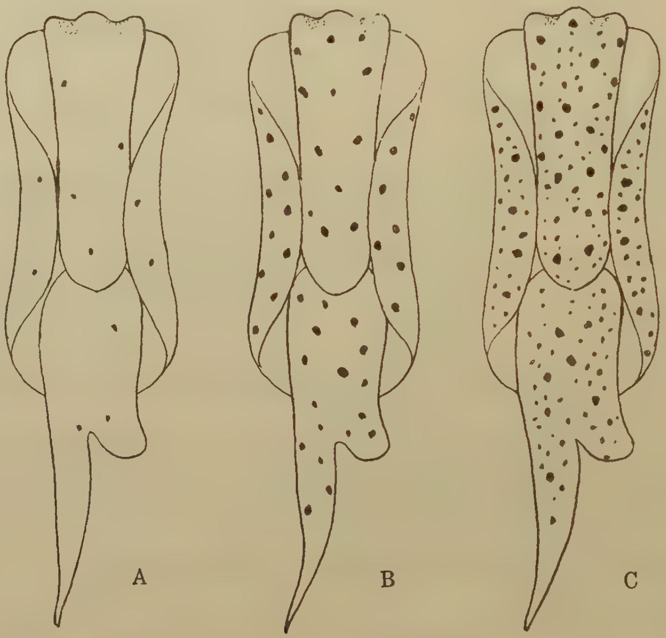

Fig. 2. *Chelidonura tsurugensis*. Distribution of the golden-yellow spots in different individuals, B. normal.

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THE DIRECT DEVELOPMENT IN *RUNCINA SETOENSIS* BABA (OPISTHOBRANCHIA-CEPHALASPIDEA)[1]

KIKUTARÔ BABA and IWAO HAMATANI[2]

Biological Laboratory, Osaka Gakugei University

With Plates XXII–XXIV and 1 Text-figure

Runcina setoensis was established by BABA in 1954. The aim of this paper is to describe the breeding biology of the species in question, with the hope of giving some additional information concerning the direct development in the genus *Runcina* (cf. VAYSSIÈRE, 1900).

Nearly every autumn during the past several years there has been an enormous increase of this species on the coasts around the Seto Marine Biological Laboratory, Seto, Japan. As noted previously (BABA, 1954, p. 374), the animal prefers to live in the shallow tide-pools of high water regions (Pl. XXII, fig. 1), and it crawls about slowly on the bare bottom or on the bed of the young *Enteromorpha* weeds (Pl. XXII, fig. 2). In some cases the specimen is hidden underneath the pebbles. There are both small and larger individuals, the length varying from 3 mm to about 7 mm. No observations have yet been made on the feeding and spawning habits of this species in its native habitat.

Our thanks are due to Dr. Huzio UTINOMI of the Marine Biological Laboratory, who has given us facilities for studying the animal and for publishing the present paper. Mrs. Ruth L. KOBS, M. A., a Fulbright instructor of English in our university, has kindly revised the English manuscript.

Spawning habits: *R. setoensis* may be kept alive in small glass vessels full of natural water. At first the newly collected animal from the sea does not lay eggs, and shows indication of trying to leave the water. It is after 6 to 7 days that the act of spawning takes place within the vessels. The following are the spawning data obtained by us in the laboratory.

The active season of spawning is from September until October, but it was not easy to breed this animal in captivity. The normal egg-masses contained from 50 to

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1) Contributions from the Seto Marine Biological Laboratory, No. 327.

2) Grant in Aid for Developmental Scientific Research of the Ministry of Education.

Publ. Seto Mar. Biol. Lab., VII (2), 1959. (Article 15)

Egg-masses No.	Collecting date	Spawning date	Egg number	Spawning temp.
I	IX-23-'57	IX-29	100	18°C
II	”	”	66	”
III	”	”	25	”
IV	X-20-'57	X-26	17	15°
V	”	X-27	70	18°
VI	”	X-28	21	”
VII	”	X-28	49	”
VIII	”	X-30	10	20°
IX	”	X-31	18	/
X	I-6-'58	I-12	14	17-19°
XI	X-14-'58	X-19	2	/
XII	”	X-22	12	21°
XIII	”	X-26	65	19°
XIV	”	X-30	2	/
XV	XI-24-'58	XI-28	2	15°
XVI	”	XII-5	15	”

100 eggs, all deposited irregularly within a viscid mucous matter (Pl. XXII, figs. 3-4; Pl. XXIII, fig. 1). The approximate size of the egg-masses is from 3 mm^2 to 4 mm^2. In the glass vessels these egg-masses are found clinging to the inner wall of the vessels, just below the surface of the water. The spawning usually takes place early in the morning or late in the evening, the whole process requiring a comparatively long time.

Developmental changes: The egg-cells of *R. setoensis* thus laid pass into the adult form while they are within the egg-capsules (direct development). The developmental rate appears to be greatly affected by the temperature of the environment. The following is a rough table of developmental changes in the egg-masses, Nos. XII and XIII, during the months of October and November, at free room temperature.

2-cells to 8-cells	1 day
8-cells to young morula	2-3 days
Primordial larval body	4-5 ”
The earliest veligers	6 ”
Rotation of veligers	7 ”
Mouth-slit opening in veligers	14-15 ”
Shell and statocysts formation	16-17 ”
Full-grown veligers	18-19 ”
Metamorphosis	20-26 ”
Intra-capsular adult form	27 ”
Hatching	38-42 ”

Egg-cells: In *R. setoensis* there appears a double membrane to each of the egg-capsules, and the outer layer is provided with fine striae on its surface. The diameter of the egg-capsules measures about 350μ; the intra-capsular space is roomy. The eggs are large, spherical, about 240-260μ across, and densely packed with deep orange-yellow yolk granules (Pl. XXII, fig. 5; Pl. XXIII, fig. 2). The maturation division occurs shortly after the eggs are laid.

Early cleavages: Quite normally, the early cleavages of the egg-cells continue, and the 8-cell stage is sometimes reached within the first day of development. The first cleavage is, as a rule, equal (Pl. XXII, fig. 6; Pl. XXIII, fig. 3), but sometimes it is unequal. At the 8-cell stage, each of the embryos consists of four micromeres which are translucent and colourless, and four macromeres which are opaque and deep orange-yellow (Pl. XXII, fig. 8; Pl. XXIII, fig. 4).

On the second or third day the micromeres proliferate to form a cap above the macromeres. The embryos at this stage are called the young morula (Pl. XXII, fig. 9; Pl. XXIII, fig. 5).

From this time on it has been difficult to follow accurately the further cleavages because of the richness of the yolk in the developing embryos. No formation of blastula and gastrula could be found by us. There is not a trochophore stage.

The embryos on the fourth and fifth days are tentatively named here as the primordial larval body (Pl. XXII, fig. 10; Pl. XXIII, fig. 6). On the outside they gradually become covered with fine cilia.

The earliest veligers: On the sixth day each of the primordial larval bodies shows the primitive features of a veliger (Pl. XXIII, fig. 7). The veliger's body in *R. setoensis* consists of: (1) a large spherical visceral sac, (2) a small protruding foot with a circular disc on the under side, and (3) a pair of velar ridges. The outer surface of the visceral sac is finely ciliated. Internally the visceral sac is packed with a yolky mass. The foot is colourless, having no cilia. The velar ridges with especially strong cilia are here referred to the velar lobes in the typical molluscan veligers.

Rotation of veligers: On the seventh day the veligers commence a rotatory movement (Pl. XXII, fig. 11), and this appears to be promoted by the strong cilia borne upon the velar ridges.

During the further growth of the veligers, from about the eighth to the eleventh day, the yolky mass of the visceral sac shows signs of being divided in two (Pl. XXII, fig. 12; Pl. XXIII, figs. 8 a-8 b). The whole integument of the body becomes clearly differentiated. It is at first colourless, but later it gets faintly yellow. On the foot-margin there appear a series of large refracting cells (mucous cells ?) among the epithelium, which soon becomes clothed with fine cilia.

Mouth-slit opening in veligers: On about the twelfth or the thirteenth day, the rudiment of a mouth-slit first appears in the veligers as a collection of yellowish cells shining through between the two velar ridges (Pl. XXII, fig. 13; Pl. XXIII, fig. 9). On the following days, from the fourteenth to the fifteenth, the actual mouth-slit opens as a marked vertical slit (Pl. XXII, fig. 14; Pl. XXIII, figs. 10 a–10 b).

Shell and statocysts formation: As the veligers continue development, minute spots of chocolate-brown come over the visceral sac. An internal shell is gradually formed just above the posterior bifurcation of the liver. It is small, opaque, and white. Paired statocysts also arise at about the boundary between the visceral sac and the foot. This stage of development is seen on about the sixteenth or seventeenth day (Pl. XXIV, fig. 1).

Full-grown veligers: Apparently the veligers are fully grown on about the eighteenth or nineteenth day, and they largely occupy the inner space of each of the egg-capsules (Pl. XXII, fig. 15; Pl. XXIV, figs. 2 a-2 b). The rotation of the veligers still goes on. The main features observed in them at this stage may be summarized as follows: (1) A pair of marked velar ridges with strong cilia; (2) a large mouth-slit between the two velar ridges; (3) the paired statocysts; (4) an internal shell; and (5) an expanded pedal disc. The general integument, including the pedal disc, is ashy yellow, and shows an increasing number of chocolate-brown spots on the visceral sac. Externally, the whole integument is finely ciliated. There are two, well-defined liver-lobes; these are symmetrical, of nearly equal size, yolky, and deep orange-yellow in colour.

Metamorphosis: After fully grown, the veligers tend to be still and inactive in rotation. It is during the days from about the twentieth to the twenty-sixth that the transformation takes place in certain organs of these embryos (Pl. XXII, fig. 16; Pl. XXIV, figs. 3 a–3 b). The most notable is the degeneration and final absence of the velar ridges; the next is the decreasing in size of the mouth-slit. Against the reducing tendency of these structures, there will arise an indication of the anus just below the shell. The pedal disc widens still more. A thicker distribution of the chocolate-brown spots is observed on the visceral sac; these spots may also be seen on the foot-margin. At about the close of the metamorphosis there appears black pigment on the visceral sac (Pl. XXIV, fig. 4), and this gradually covers the ashy yellow ground-colour of the mantle. The veligers which have undergone metamorphosis now assume the general appearance of an adult.

Intra-capsular adult form: The metamorphosed embryos remain within each of the egg-capsules still longer, and very slowly they keep on rotating (Pl. XXIV, figs. 5 a–5 b). On about the twenty-seventh day the embryos appear to be more or less elongated: there are no velar ridges; the black pigment prevails on the mantle-surface; clusters of black spots mark the head-region on each side; the mouth-slit is decreased; the shell denotes the posterior end of the mantle; the anus clearly opens below the shell. The chocolate-brown spots are thick on the visceral sac, but less so on the pedal disc. The pedal disc widens noticeably, with the entire margin curving upward. The black pigmentation appears on the foot-margin and around the anus. The paired liver-lobes decrease in size.

The succeeding development is only gradual. During this period the somewhat enlarged and lengthened embryos appear to roll up in the limited space of the egg-capsules (Pl. XXII, fig. 17; Pl. XXIV, figs. 6 a–6 b). The embryos are now prepared to hatch.

Hatching: From spawning to hatching, the whole development of the embryos takes from about 38 to 42 days. At the time of hatching the egg-capsules are swollen for easy bursting of the wall; the embryos are thus allowed to pass out in full extension (Pl. XXII, fig. 18; Pl. XXIV, figs. 7 a–7 b).

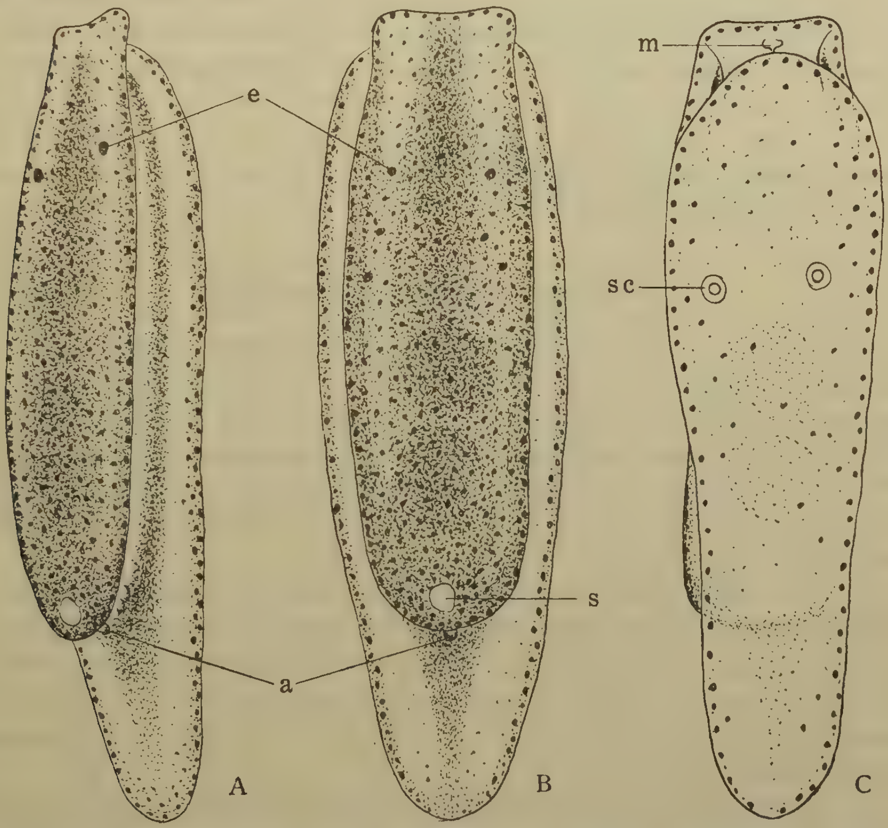

Fig. 1. The young individuals of *Runcina setoensis*, immediately after hatching. L. 600μ. A. lateral, B. dorsal, C. ventral. a. anus, e. eye, m. mouth, s. shell, sc. statocyst.

As previously stated, these embryos are much like the adult in general form and in colouring (Pl. XXII, fig. 19; Text-fig. 1, A–C). The total length of them measures about 600μ. The whole embryo consists of the visceral sac or the mantle, the sides, and the foot. It is finely ciliated everywhere.

The ground-colour of the integument is ashy yellow. On the mantle the richly distributed chocolate-brown spots become almost hidden by the prevailing black pigment, which is thickest in the median part and around the margin. A pair of black-pigmented eyes is in the head-region. A few additional black spots may occur near each of the eyes. Deep orange-yellow liver-lobes, greatly reduced in size, lie within the posterior half of the visceral sac. At the posterior end of the mantle is a small, opaque, white, internal shell. Just below the shell opens the anus, which is marked by a black border. A deep black band is formed on each side of the body, on foot-margins, and on the tail in the middle line. A small, not black-pigmented mouth-slit appears on the under side of the head. The pedal disc is ashy yellow, with chocolate-brown spots that tend to be arranged in a series near the margins. A pair of statocysts is visible through the transparent sole.

The young individuals were kept alive for two weeks more, and then killed. They attained the length of about 700μ. The gills, the genital orifices, and the genital groove were not well developed at that time.

Summary, with short discussions

1. The first record of the direct development in the genus *Runcina* is that of *R. coronata* (QUATREFAGES) by VAYSSIÈRE, 1900, but the accounts given by him are inadequate. The second recording is here made by us for *R. setoensis* BABA. As to the species of the direct development in the order Opisthobranchia, see BABA, 1937.

2. At Seto, Japan, the species *setoensis* appears on shores abundantly from September to November, and the most active season for spawning is during September and October. The individuals are 3–7 mm in length.

3. The spawning has been observed in the laboratory glass vessels only. The egg-masses have no definite shape as in *R. coronata*, and normally contain 50–100 eggs.

4. The egg-cells are very large compared to the size of the parent, being 240–260μ across, thickly yolk-laden, and deep orange-yellow in colour. The eggs in many opisthobranchs are more or less than 100μ. In *R. setoensis* each of the egg-capsules has a double membrane.

5. During October and November at free room temperature, it took from about 38 to 42 days for the whole development within the egg-capsules. At the close of this period the embryos, nearly in an adult form, became free.

6. The earliest cleavages are approximately as usual. It was hardly possible to determine the formation of the blastula and the gastrula accurately. There was no trochophore stage. The primordial larval bodies are covered with fine cilia, and these pass into the veliger stage.

7. The veligers of *R. setoensis* are very much modified, but they may be called as such if we consider the strongly ciliated velar ridges of *setoensis* to be similar in function to the velar lobes in many molluscan veligers.

8. The veliger's body consists of a large spherical visceral sac and a circular pedal disc. During the formation of the mouth-slit between the two velar ridges, there arise a pair of statocysts and an internal shell. No external nautiloid shell or operculum was seen during the course of the development. The veligers are in active rotation.

9. The metamorphosis which occurs at about the middle of the whole development is shown by the degeneration of the velar ridges. The mouth-slit, which lies in front, decreases in size. The anus, found on the posterior side of the embryo, begins to open just below the shell.

10. Next comes the intra-capsular adult form. The body elongates, the black pigment develops on the visceral sac, and the embryos await hatching. The newly freed individuals are about 600μ long.

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Postscript

A brief observation on the direct development of *Runcina elioti* BABA was made at Seto by HAMATANI in January, 1958 (spawning on Jan. 9th).

EXPLANATION OF PLATES XXII–XXIV

PLATE XXII

(Figs. 5–17, ×100)

Fig. 1. Collecting of *Runcina setoensis* from the tide-pool zone near the Seto M. B. L. (IX–'57).

2. *R. setoensis* in the native habitat (X–'58). L. 7 mm.
3. The egg-mass No. II, deposited in the laboratory glass vessel (IX–'57). ×7.
4. Part of the egg-mass. ×25.
5. Newly laid egg-cell in maturation division. Same figure as Pl. XXIII, fig. 2.
6. 2–cells. Same figure as Pl. XXIII, fig. 3.
7. 4–cells.
8. 8–cells on the second day. Roughly the same figure as Pl. XXIII, fig. 4. Four micromeres at the animal and four macromeres at the vegetal pole.
9. Young morula on the third day. Roughly the same figure as Pl. XXIII, fig. 5. Cap of micromeres at the animal pole.
10. Primordial larval body on the fifth day. Fine ciliation on the whole surface. A day later than Pl. XXIII, fig. 6.
11. Earliest veliger on the seventh day, from the posterior side. Commencement of rotation. A spherical visceral sac above, and a small protruding foot below. A day later than Pl. XXIII, fig. 7.
12. Veliger on the ninth day, from the anterior side. Roughly the same figure as Pl. XXIII, fig. 8 a.
13. Veliger on the twelfth day, from the posterior side. Formation of the rudiment of a mouth-slit. Same stage as Pl. XXIII, fig. 9.
14. Veliger on the fifteenth day, from the anterior side. Actual opening of the mouth-slit. Roughly the same figure as Pl. XXIII, fig. 10 a.
15. Full-grown veliger on the eighteenth day, from the postero-lateral side. Roughly the same figure as Pl. XXIV, fig. 2 b.
16. Veliger in metamorphosis on the twenty-second day. The visceral sac above, and the pedal disc below. Roughly the same stage as Pl. XXIV, fig. 3 a.
17. Intra-capsular adult form on the twenty-eighth day, from the left side. Roughly the same figure as Pl. XXIV, fig. 6 b.
18. Hatching of the young individuals (×35) on about the forty-second day. Roughly the same figures as Pl. XXIV, figs. 7 a–7 b.
19. A newly hatched individual from above. L. 600μ. Same figure as text-fig. 1, B.

Plate XXIII

(Figs. 2–10 b, ×120)

Fig. 1. The egg-mass No. V, deposited in the laboratory glass-vessel (X–'57). ×17.

2. Newly laid egg-cell in maturation division. Egg diameter 240–260μ.

3. 2 cells.

4. 8 cells. Four micromeres at the animal and four macromeres at the vegetal pole.

5. Young morula on the third day. Cap of micromeres at the animal pole. With 3 polar bodies above the cap.

6. Primordial larval body on the fourth day. Fine ciliation begins to develop on the surface.

7. Earliest veliger on the sixth day, from the posterior side. Showing the visceral sac above, and the small protruding foot below.

8 a. Veliger in rotation on the ninth day, from the anterior side. Showing a pair of strongly ciliated velar ridges.

8 b. The same, from the posterior side.

9. Veliger on the twelveth day, from the anterior side. Formation of the rudiment of a mouth-slit.

10 a. Veliger on the fifteenth day, from the anterior side. Actual opening of the mouth-slit between the two velar ridges. Liver clearly divided in two. Chocolate-brown spots appearing on the visceral sac.

10 b. The same, from the posterior side.

Plate XXIV

(Figs. 1–7 b, ×120)

Fig. 1. Veliger on the sixteenth day, from the posterior side. Showing the formation of a shell and paired statocysts.

2 a. Full-grown veliger on the eighteenth day, from the anterior side.

2 b. The same, from the posterior side.

3 a. Veliger in metamorphosis on the twenty-second day, from the right side.

3 b. The same, from the anterior side.

4. Veliger on the twenty-fifth day, from the anterior side. At about the close of the metamorphosis. The velar ridges are about to disappear entirely; the highly decreased mouth-slit is almost invisible between the visceral sac and the foot.

5 a. Intra-capsular adult form on the twenty-seventh day, from the anterior side. Black pigmentation prevails over the visceral sac.

5 b. The same, from the posterior side. The anal opening clearly visible just below the shell.

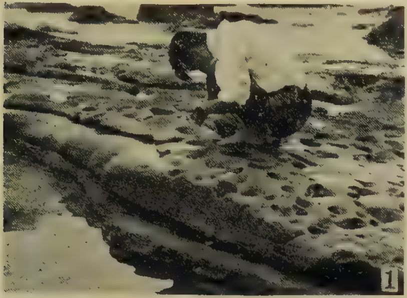
6 a. The intra-capsular adult form on the thirty-second day, slightly from the antero-lateral side. The enlarged and lengthened embryo appearing to roll up within the egg-capsule. With an exceedingly expanded pedal disc.

6 b. The same, slightly from the postero-lateral side.

7 a. Hatching of the young individual on about the forty-second day, from the right side.

7 b. The same, from the posterior side.

Abbreviations: A. anus; m. mouth-slit; p. foot or pedal disc; s. shell; sc. statocyst; vr. velar ridge; vs. visceral sac. Anterior side=oral side. Posterior side=anal side.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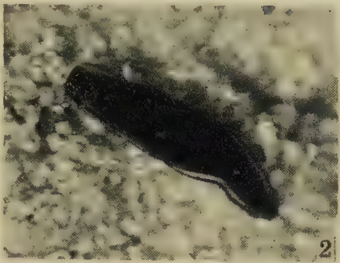
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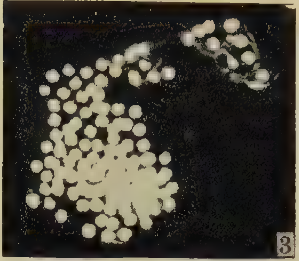
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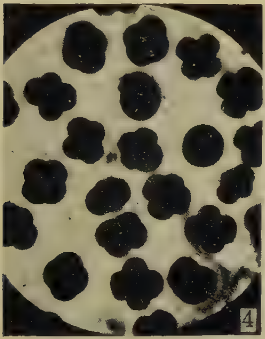
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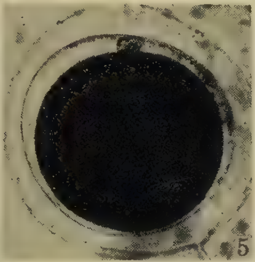
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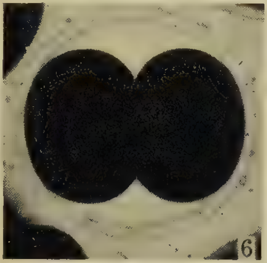
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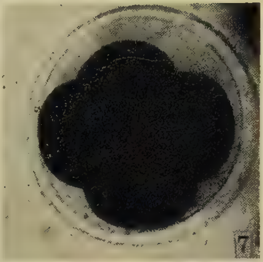
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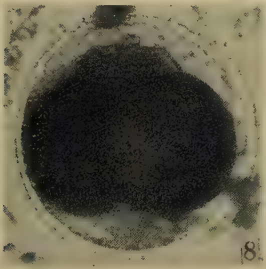
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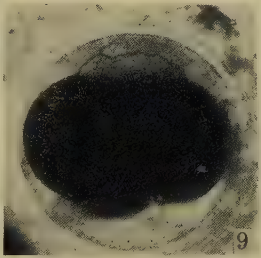
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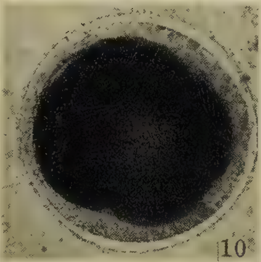
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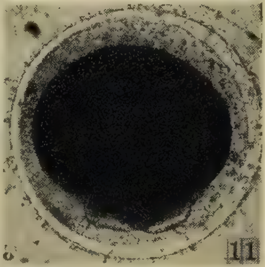
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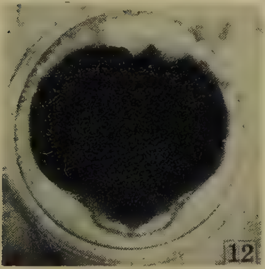
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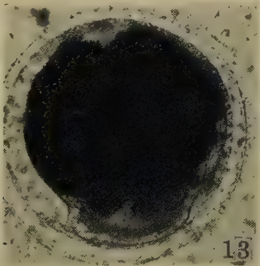
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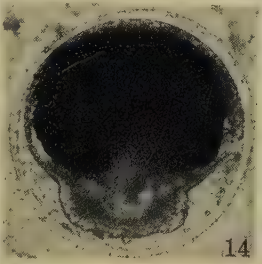
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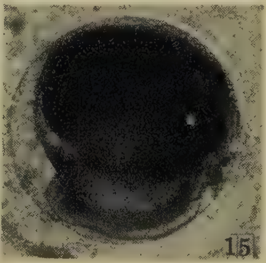
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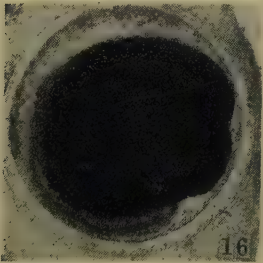
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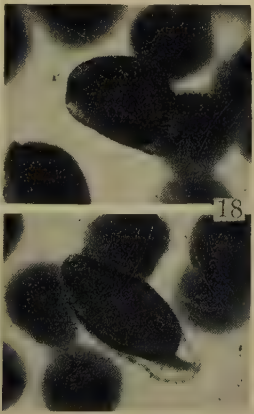
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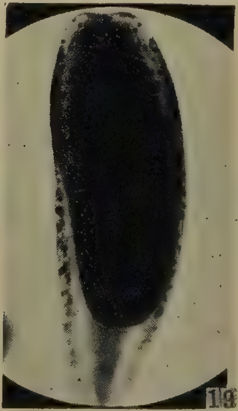
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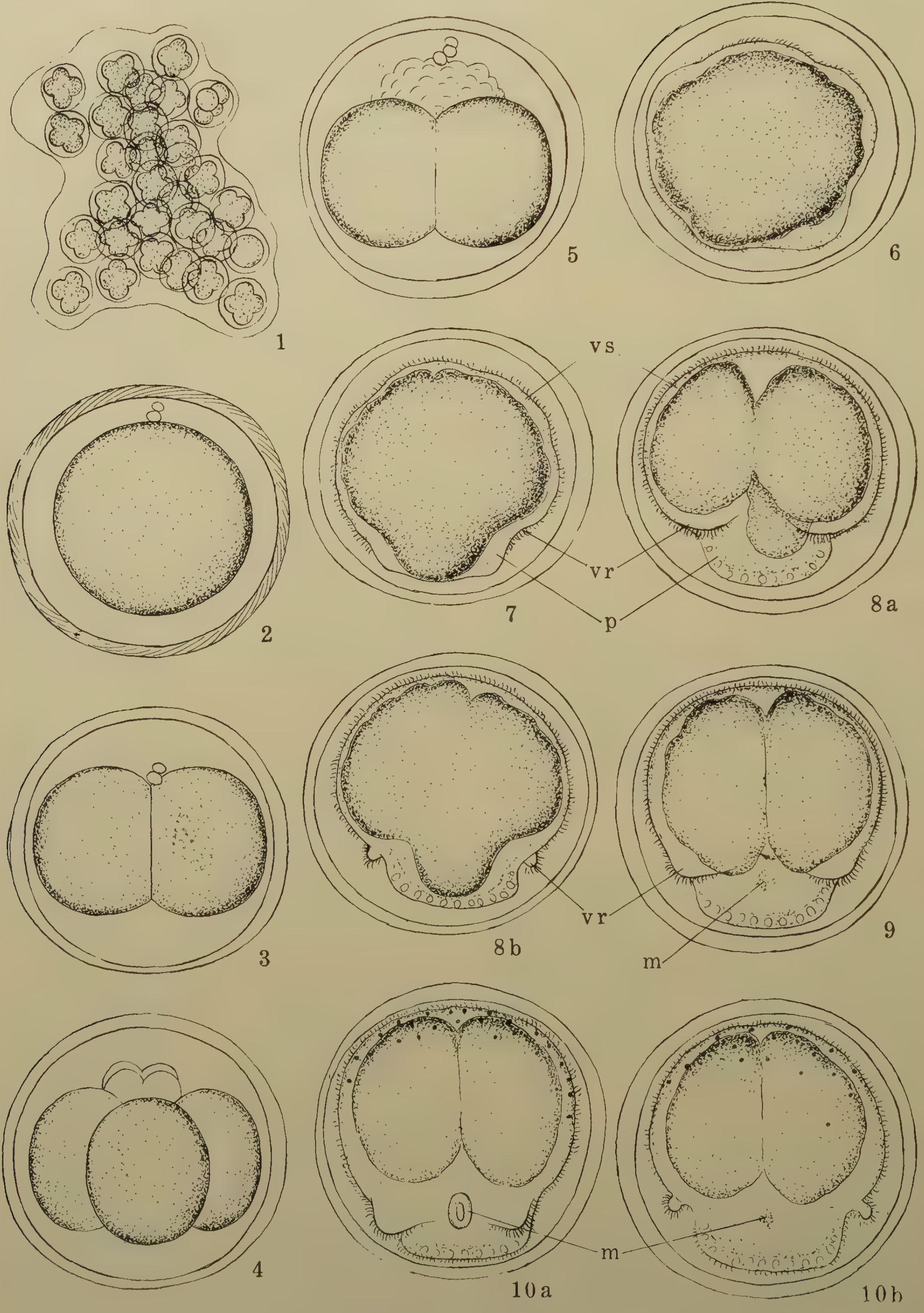
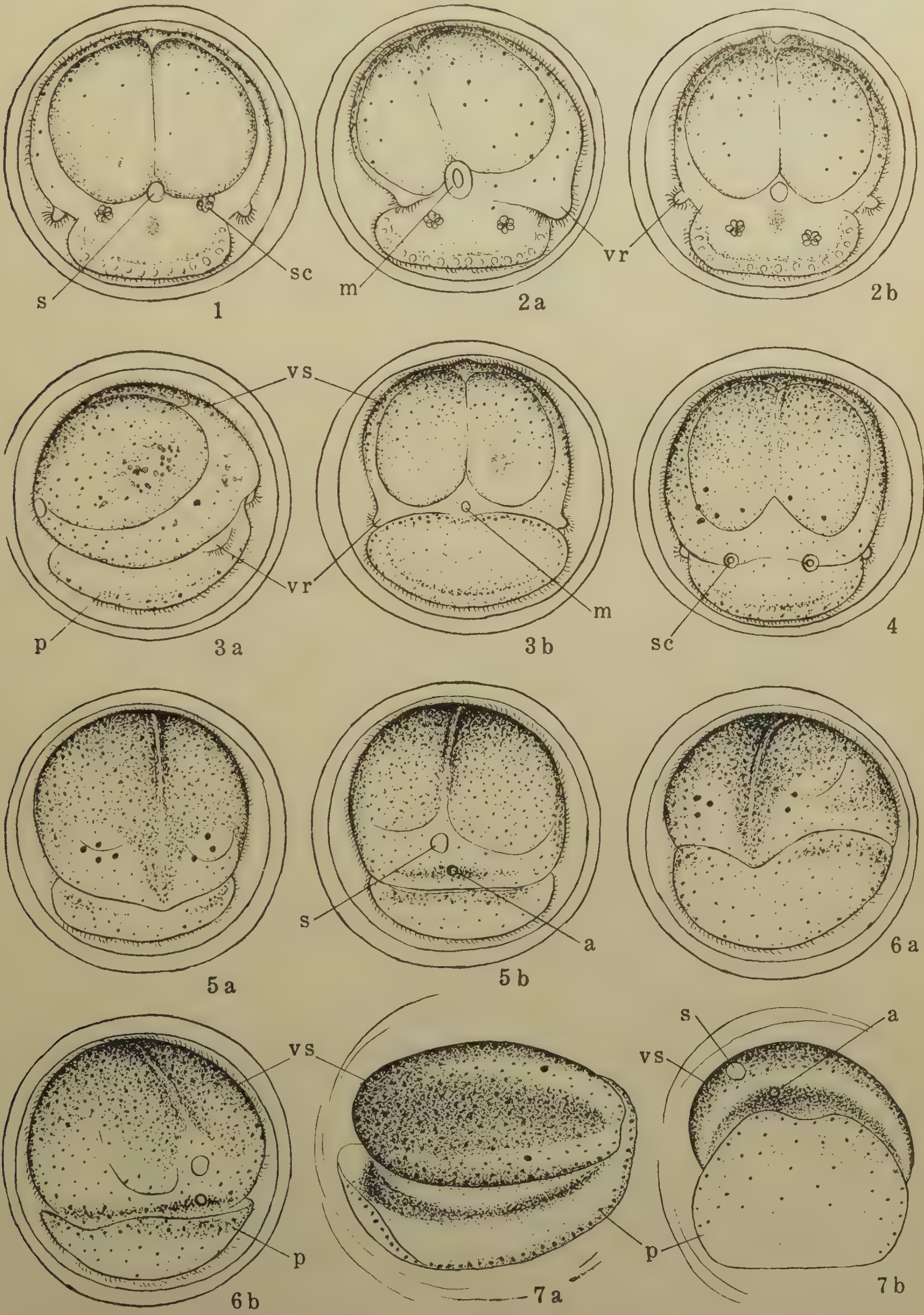
K. Baba and I. Hamatani: Direct Development in *Runcina setoensis* Baba.



K. BABA AND I. HAMATANI: DIRECT DEVELOPMENT IN *RUNCINA SETOENSIS* BABA.

PLATE XXIV



K. Baba and I. Hamatani: Direct Development in *Runcina setoensis* Baba.

FIVE NEW MINUTE BIVALVES FROM JAPAN (ERYCINACEA, PELECYPODA)[1,2]

TADASHIGE HABE

Amakusa Marine Biological Laboratory
(Kyushu University)

With 15 Text-figures

The minute molluscs are still inadequately known in Japan. Therefore there are many undetermined species before the writer. These five new bivalves here described are widely found in the bays of Japan, but have never been named elsewhere.

Family Erycinidae

Kellia tsujitai sp. nov.

(Text-figs. 1, 2)

Shell is small, but rather thick, light yellowish white, tumid, suborbicular, slightly longer than high. Ventral margin is rather straight. Surface is dull, with the roughened growth lines and two obtuse angles run to the antero-ventral and postero-ventral corners from the prominent umbo. In the left valve a projecting conical cardinal tooth is just under the umbo and a small anterior cardinal on the hinge plate and the posteior lateral tooth is narrow but distinct. In the right valve a conical cardinal tooth and a narrow slot for the reception of the corresponding tooth on the left valve. A large brown resilium between the cardinal teeth and posterior lateral tooth on the left valve.

Length 4.7 mm, height 4.1 mm and breadth 1.5 mm. (left valve) (type specimen)
Length 4.6 mm, height 3.7 mm and breadth 1.2 mm. (left valve)

Type locality: Ariake Sea, Kyushu.

Distribution: Hakata Bay, Fukuoka Pref. and Amakusa, Kumamoto Pref., Kyushu; Tanabe Bay, Wakayama Pref., Honshu.

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1) Contributions from the Amakusa Marine Biological Laboratory (Kyushu University), No. 128.

2) Contributions from the Seto Marine Biological Laboratory, No. 328.

Publ. Seto Mar. Biol. Lab., VII (2), 1959. (Article 16)

Remarks: This species very closely relates to *K. japonica* PILSBRY which may be a synonym of *K. subrotunda* DUNKER and *K. porculus* PILSBRY, but is quite smaller and thicker even in the adult, with the roughened dull surface.

The writer takes pleasure in naming this new species in honor of Dr. Tokimi TSUJITA of the Seikai Regional Fisheries Laboratory in Nagasaki.

Genus *Borniopsis* nov.

Type species: *Borniopsis tsurumaru* sp. nov.

Shell is small, ovate, rather thick, light yellowish white to light purplish white, flat to moderately inflated. The postero-dorsal margin is shorter than the postero-dorsal owing to the greatly produced anterior part. Therefore the small umbo places one third from the posterior end. Surface with the fine radial threads all over. The left valve with two divaricating cardinal teeth, the anterior one being stronger and between them an internal ligament fixes, but right valve with one small tooth between the anterior and posterior cardinals.

Remarks: This new genus closely resembles the genera *Borniola* IREDALE and *Byssobornia* IREDALE in the surface sculpture, but has a thicker shell which is ovate in shape. The hinge armature is also differentiated this new genus from other two genera in having the narrow hinge plate with a weak lateral groove on the right valve.

Recently three species belonging to this new genus were found: namely *Montacuta yamakawai* YOKOYAMA (=*Mysella yamakawai* by Is. TAKI and OYAMA), *Borniopsis tsurumaru* sp. nov. and *Borniopsis ariakensis* sp. nov. The first species was described for so young specimens that it was only known imperfectly.

Borniopsis tsurumaru sp. nov.

(Text-figs. 10–12)

Shell is rather thick, light yellowish white, ovate, strongly produced anteriorly. Therefore the umbo places hinder than the middle of the dorsal margin. Surface with weak growth lines, but some of them are distict and distantly places as resting stages. Fine radiating threads run all over the surface.

Length 10.7 mm, height 7.4 mm and breadth 2.1 mm. (left valve) (type specimen)
Length 10.7 mm, height 7.5 mm and breadth 2.2 mm. (right valve)

Type locality: Ariake Sea, Kyushu.

Distribution: Tanabe Bay, Wakayama Pref., Ago Bay, Mie Pref., Mikawa Bay, Aichi Pref., Maizuru Bay, Kyoto Pref. and Nanao Bay, Ishikawa Pref., all of Honshu.

Remarks: The 'Tsurumaru' is a ship of the Fisheries Experiment Station of Nagasaki Prefecture, by which the first fisheries survey of Ariake Sea was carried out in 1957 and the writer obtained this new species from the inner part of this bay.

Borniopsis ariakensis sp. nov.

(Text-figs. 13-15)

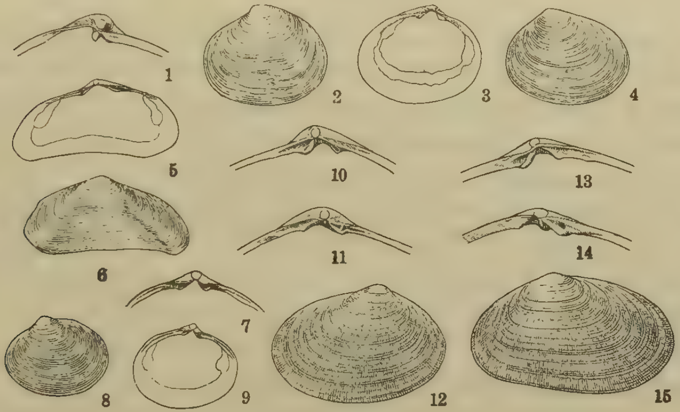
Shell is rather flat, light purplish white, rather thick, elongated ovate. The frontal part from the umbo is longer than the hinder. Surface with very fine radial threads and also fine growth lines all over. The latter is sometimes strong indicating the resting periods.

Length 12.3 mm, height 7.9 mm and breadth 2.4 mm. (right value) (type specimen)

Length 9.2 mm, height 4.2 mm and breadth 1.6 mm. (left valve)

Type locality: Ariake Sea, Kyushu.

Distribution: Maizuru Bay, Kyoto Pref., Honshu.



Text-figs. 1, 2. *Kellia tsujitai* sp. nov., 3, 4. *Montacutona tanakai* sp. nov., 5, 6. *Curvemysella paula* (A. ADAMS), 7–9. *Montacutona olivacea* sp. nov., 10–12. *Borniopsis tsurumaru* gen. et sp. nov., 13–15. *Borniopsis ariakensis* sp. nov.

Family Montacutidae

Montacutona tanakai sp. nov.

(Text-figs. 3, 4)

Shell is small, flat. and orbicular in shape. Umbo is a little anterior from the middle of the dorsal margin. Surface is smooth and polished and marked weak growth lines only. In the left valve, the resilium between the two cardinal teeth which are rather strong and divaricate widely. In the right valve the dorsal margin fixes into groove between the dorsal margin and the solid cardinal teeth of the opposite valve.

Length 4.6 mm, height 4.0 mm and breadth 1.0 mm. (left valve) (type specimen)

Type locality: Ariake Sea, Kyushu.

Distribution: Tanabe Bay, Wakayama Pref., Ago Bay. Mie Pref., Maizuru Bay, Kyoto Pref., all of Honshu.

Remarks: This new species is close to *M. mutsuwanensis* YAMAMOTO and HABE, but has a distinctly oblique umbo to anterior direction. *Montacutona japonica* (YOKOYAMA) is also an allied form to this new species, but has a more oblique shell with more solid cardinal teeth. This species was collected from Tanabe Bay and Miho Bay, Tottori Pref., Honshu.

The specific name is dedicated to Mr. Yataro TANAKA of the Hama Branch of the Seikai Regional Fisheries Laboratory who collected this new species from this Bay.

Montacutona olivacea sp. nov.

(Text-figs. 7–9)

This new species is quite similar to the preceding species in shape, but has a thin shell colored in olive. The left valve has the widely divaricated cardinal teeth and the shallow grooves along both the anterior and posterior dorsal margins.

Length 6.0 mm, height 4.6 mm and breadth 1.1 mm. (left valve) (type specimen)

Type locality: Maizuru Bay, Kyoto Pref., Honshu.

Distribution: Tanabe Bay, Wakayama Pref., Ago Bay, Mie Pref. and Miho Bay, Tottori Pref., all of Honshu.

Genus *Curvemysella* nov.

Type species: *Mysella paula* A. ADAMS (Text-figs. 5, 6).

Mysella paula A. ADAMS is not a real member of the genus *Mysella* ANGAS in having the hinge armature of *Montacuta*-type and has the close relationships to the genus *Montacuta* rather than the genus *Mysella*. The shell curves owing to the symbiotic life with the hermit crab and the anterior cardinal tooth is elongate along the anterior dorsal margin. This peculiar features give a new genus *Curvemysella* for this species.

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ECOLOGY OF SHALLOW-WATER FORAMINIFERA OFF THE COAST OF NOBORIBETSU, SOUTHWESTERN HOKKAIDO, JAPAN

TAKAYASU UCHIO

Petroleum Engineering Inst., University of Tokyo

With 3 Text-figures and 2 Tables

Introduction

In the late summer of 1958, eleven bottom sediments were collected off the coast of Noboribetsu, near Muroran, Hokkaido, by the members of the Japanese Hydrographic Office. The locations, depths, types of sediments and dates of collection of these samples are listed in Table 1 and are shown in Fig. 1.

The sediments were collected by using a dredge, dried on the survey ship. They were dried in an electric oven for a few hours, weighed, then washed by running water through 250-mesh sieve (diameter of the opening is 0.06 mm) in the laboratory. The part retained on the 250-mesh sieve was placed in an evaporating dish, dried in an oven. Foraminifera were floated from the dried sediment by using CCl_4 according to the method developed by Y. OZAWA at the Cushman Laboratory (CUSHMAN, 1940, p. 27). All of floated and unfloated specimens of each sample were analyzed for species quantitatively. Therefore, the Foraminifera assemblages here dealt with are thanatocoenoses, which may include a few living specimens.

The writer wishes to express his cordial thanks to Messrs. Ryoji SEKIZUKA, Shigeru MOGI and Ninko SATO of the Japanese Hydrographic Office for submitting the material to the writer's disposal; to Prof. Tomofusa MITSUCHI of the University of Tokyo and to Prof. Takasi TOKIOKA of the University of Kyoto for their constant encouragement and advice.

Submarine Topography and Geology

According to the Hydrographic Chart 17 published by the Japanese Hydrographic Office, the submarine topography of this area is simple (see Fig. 1). There is a narrow (*ca.* 15 km wide) continental shelf down to a depth of *ca.* 100 m. The shelf can be divided into two parts. The inner one is a narrow (*ca.* 3.5 km wide), rather

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steeply sloping (*ca.* 0°35′) zone, the lower edge of which lies at a depth of 50–60 m. The outer one is an almost horizontal terrace. These characters show that the continental shelf of this area is in close agreement with SHEPARD's statistics (1948, p. 144) that the average slope is 0°07′, being somewhat steeper in the inner half than the outer half.

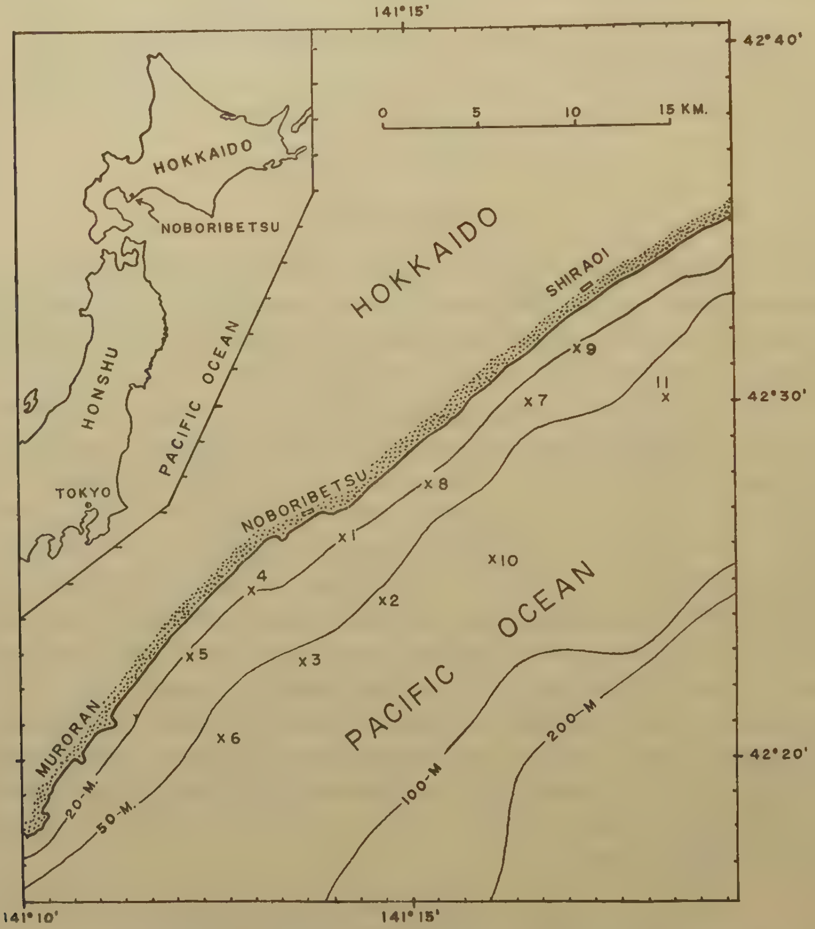

Fig. 1. Locations of stations and the submarine topography of the area.

The bottom shallower than 20 m is covered by sand, and the deeper part by silty sand (mud and sand in Table 1) or silt (mud in Table 1). Frequently these sediments contain a rather large quantity of pumice grain (except at Stations 3 and 4), and also plant fragments to a lesser extent. *Acila (Truncacila) insignis* (GOULD) is abundant at Station 5, where both (right and left) valves of each individual were tied firmly together. This indicates that the fauna at Station 5 might

Table 1. Locations of stations, depths, types of sediments, and dates of collections.

Station	Location		Depth (m)	Sediment	Date
	N. Lat.	E. Long.			
1	42° 26′ 11″	141° 12′ 27″	22	Sand & Mud	1958 Aug. 30
2	42° 24′ 24″	141° 13′ 54″	65	Mud	1958 Aug. 30
3	42° 22′ 49″	141° 11′ 02″	59	Mud	1958 Aug. 30
4	42° 24′ 44″	141° 08′ 57″	19	fine Sand	1958 Aug. 30
5	42° 22′ 53″	141° 06′ 35″	28	Mud & Sand	1958 Aug. 30
6	42° 20′ 37″	141° 07′ 44″	56	Mud	1958 Aug. 31
7	42° 30′ 02″	141° 19′ 38″	29	Sand & Mud	1958 Sept. 11
8	42° 27′ 45″	141° 15′ 52″	31	Sand & Mud	1958 Sept. 11
9	42° 31′ 30″	141° 21′ 35″	23	Pumice	1958 Sept. 14
10	42° 25′ 37″	141° 18′ 15″	80	Mud & Sand	1958 Sept. 15
11	42° 30′ 06″	141° 24′ 48″	70	Sand & Mud	1958 Sept. 23

be deposited *in situ.* Grain size analysis of these sediments will be made by Ninko SATO of the Japanese Hydrographic Office in the near future.

Hydrography

Since the Foraminifera assemblages here dealt with are not biocoenoses but thanatocoenoses, there may be no direct relationship between the thanatocoenoses and hydrographic phenomena. Nevertheless, the thanotocoenoses might indirectly be related to the average oceanographic conditions during the past few hundreds or thousands years. It is, therefore, necessary to analyse hydrographic data to understand fully what causes faunal distributions. In the following the writer gives a general picture of the oceanographic conditions in this area and its surroundings.

Very few oceanographic data are available in the area concerned, while so many data have been published in the neighbouring areas every ten days by the Hakodate Marine Observatory and others. The reasons are that this area has importance neither in fishery nor in oceanographic-meteorological observations. There are three surface water masses (warm Tsugaru Current, warm Kuroshio and cold Oyashio) in the general area concerned.

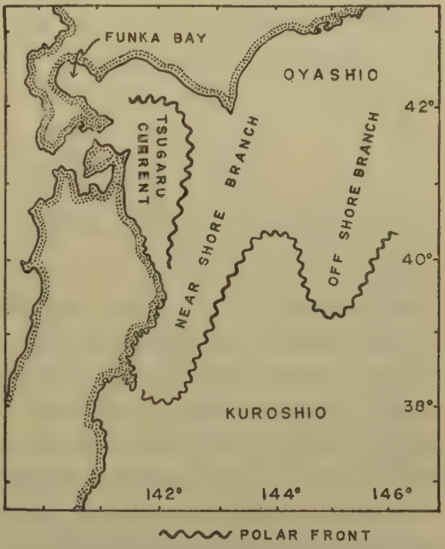

Fig. 2. Generalized pattern of distributions of the three currents in the waters off N.E. Honshû, Japan.

The seasonal and yearly fluctuations of these water masses determine the oceanographic-meteorologic, faunal and floral patterns of the area. A generalized pattern of distributions of the three currents is shown in Fig. 2. As is shown in Fig. 2, the area here studied is almost always covered by a westerly or northwesterly extension, though much modified by mixing with Tsugaru Current, of the nearshore branch of the subarctic Oyashio, but the warm Tsugaru Current may give influences to the area in summer. Below the Oyashio there lies the Intermediate Water, which is characterized by a salinity minimum (less than 33.8‰). The thickness of the Oyashio is variable locally and not well known. According to Uda (1938) the low salinity and low density Oyashio is about 25 m in thickness, and between 50 and 150 m in depth there is the cold Intermediate Water, whose density is high and salinity is nearly constant. He does not mention the layer between 25 and 50 m in depth, but it appears to be a thermocline.

Fig. 3 shows approximate maximum and minimum water temperatures and salinities in this area in relation to depth according to the results of marine meteorological-oceanographical observations published by the Central Meteorological Observatory.

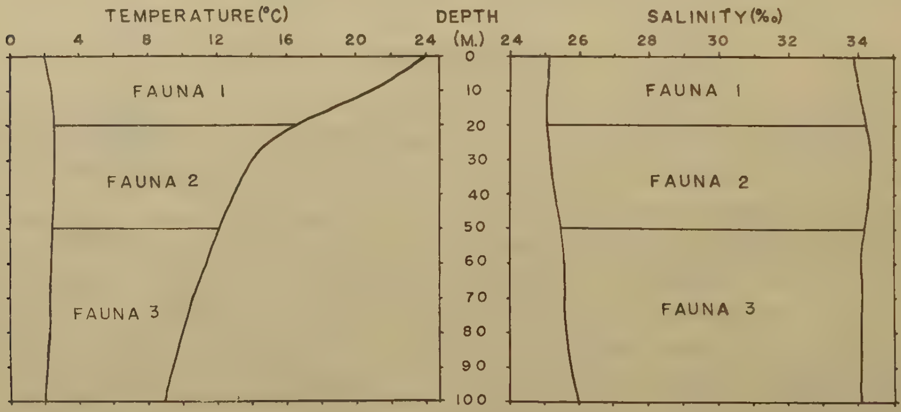

Fig. 3. Maximum and minimum bottom temperatures and salinities in relation to depth.

Maximum temperature of the surface water is 24°C., which is an extreme during the recent 10 years. The average of maximum temperatures in each year will be about 19–20°C. In general temperature and salinity are the lowest in January and February and the highest in August and September, and the reverse is true in the case of oxygen content in waters. Amount of the dissolved oxygen in water in this area is 5–8 cc/L and decrease from the surface toward the deep. The water is oversaturated and sometimes nearly saturated with oxygen within a depth range of 0–100 m.

Hidaka (1934), from the distributions of temperature and salinity, could find a boundary at about 25 m, which divides waters into two layers along a traverse at the entrance of Funka-wan (Volcanic Bay). Furthermore, he, in the main part of the bay, could find a very distinct boundary at 50 m, above which there are inflow of water from the Pacific Ocean into the bay along the southern shore, a horizontal and clockwise gire, a sinking water at the center of the bay, and an upwelling along the shore of the bay, while below which there is an outflow of water from the bay to the Pacific Ocean along the northern shore of the bay. He also pointed out that the water was stagnant below 90 m in the bay and there was no exchange of water between the bay and Pacific Ocean below that level. MATSUDAIRA and MIZUUCHI (1934) reached the same conclusion from the distribution of oxygen, phosphate, silicate and pH.

Foraminifera Depth Assemblages and Boundaries

The Foraminifera here dealt with are divided into three assemblages, and the deepest one may be subdivided into two. These divisions are based upon the following criteria: shallow and/or deep limit of the various species, and depth range at which the species have the greatest frequency. Occurrences of the species of benthonic Foraminifera are listed in Table 2.

Fauna 1 is represented by only one sample, and more materials are necessary to establish this assemblage. The shallow limit of this assemblage is unknown, and deep one is at depth of *ca.* 20 m. The assemblage is characterized by predominance of *Pseudononion japonicum* ASANO, and also by *Buccella frigida* (CUSHMAN).

The boundary at *ca.* 20 m is based upon great change in frequency occurrences of *Pseudononion japonicum* ASANO, *Eggerella advena* CUSHMAN and *Elphidium clavatum* CUSHMAN.

Fauna 2 is characterized by the predominance of *Eggerella advena* CUSHMAN and *Elphidium clavatum* CUSHMAN. *Pseudononion japonicum* ASANO, *Buccella frigida* (CUSHMAN) and *Elphidium subarcticum* CUSHMAN are also important members of this assemblage.

The boundary at *ca.* 40–50 m is very distinct and is based upon:

1) *Nonionella stella* CUSHMAN & MOYER becomes dominant suddenly.
2) *Eggerella advena* CUSHMAN, *Elphidium clavatum* CUSHMAN become much less dominant.
3) *Pseudononion japonicum* ASANO, *Elphidium subarcticum* CUSHMAN, *Lagenammina diffulgiformis* var. *lagenaria* (BERTHELIN), *Elphidium oregonensis* CUSHMAN & GRANT, *Quinqueloculina* sp. cf. *Q. seminula* (LINNAEUS) and *Streblus japonicus* (HADA) become extinct or almost extinct in Fauna 3.
4) *Textularia earlandi* PARKER, *Trochammina squamata stellata* HÖGLUND, *Epistominella tamana* (KUWANO), *Buccella frigida* (CUSHMAN) and *Reophax communis* LACROIX become more abundant in Fauna 3.
5) *Trochammina pacifica* CUSHMAN, *Goësella flintii* CUSHMAN, *Haplophragmoides bradyi* (ROBERTSON), *Lagena mollis* CUSHMAN, *Fissurina laevigata* REUSS, *Uvigerina cushmani* TODD, *Virgulina* sp., *Alveolophragmium crassimargo*

Table 2. Percentage distribution of the benthonic Foraminifera off the coast of Noboribetsu, Hokkaido, Japan.

Fauna	1	2				3A				3B
Station	4	1	5	7	8	6	3	2	11	10
Depth (m)	19	22	28	29	31	56	59	65	70	80
Pseudnonion japonicum	68	14	20	12	20	—	×	—	—	—
Buccella frigida	14	10	9	5	6	8	2	×	8	3
Elphidium subarcticum	5	14	3	3	3	—	—	—	1	×
Elphidium clavatum	5	20	16	20	14	11	2	—	11	24
Eggerella advena	4	38	44	52	49	18	23	8	5	17
Elphidium oregonense	2	×	×	×	×	—	—	—	—	—
Quinqueloculina cf. *seminula*	2	2	×	—	×	—	—	—	—	—
Lagenammina lagenarium	—	×	1	1	3	×	×	—	—	—
Textularia earlandi	—	×	2	×	1	6	7	1	—	×
Trochammina charlottensis	—	×	—	1	×	—	2	—	2	—
Buliminella elegantissima	—	×	2	2	×	—	×	—	1	×
Streblus japonicus	—	×	—	×	×	—	—	—	—	—
Trocchammina squamata stellata	—	—	×	×	×	8	4	6	8	3
Nonionella stella	—	—	1	×	×	39	47	7	48	×
Epistominella tamana	—	—	×	—	×	7	4	7	2	8
Reophax communis	—	—	×	—	—	—	2	2	—	2
Involutina cf. *minutissimum*	—	—	—	×	—	—	—	—	—	—
Nonion cf. *manpukujiense*	—	—	×	×	×	—	—	—	—	—
Trochammina pacifica	—	—	—	—	—	1	×	×	×	3
Goësella flintii	—	—	—	—	—	1	×	—	—	—
Fissurina laevigata	—	—	—	—	—	1	×	—	—	—
Haplophragmoides bradyi	—	—	—	—	—	×	×	—	—	×
Uvigerina cushmani	—	—	—	—	—	×	×	1	2	16
Alveolophragmium crassimargo	—	—	—	—	—	×	1	×	—	×
Cassidulina nörvangi	—	—	—	—	—	×	—	2	9	9
Glandulina laevigata	—	—	—	—	—	×	×	×	—	—
Cassidulina subglobosa	—	—	—	—	—	×	—	—	×	—
Lagena mollis	—	—	—	—	—	—	×	—	—	×
Lagena striata	—	—	—	—	—	—	×	—	—	—
Virgulina sp.	—	—	—	—	—	—	×	×	—	×
Haplophragmoides (?) sp.	—	—	—	—	—	—	×	×	—	—
Gyroidina cf. *soldanii*	—	—	—	—	—	—	×	—	—	—
Ammotium cassis	—	—	—	—	—	—	×	×	—	—
Asterigerinata cf. *pacifica*	—	—	—	—	—	—	—	×	×	—
Reophax scorpiurus	—	—	—	—	—	—	—	×	—	×
Nonion labradoricum	—	—	—	—	—	—	—	—	—	×
Elphidium bartletti	—	—	—	—	—	—	—	—	—	×
Quinqueloculina cf. *elongata*	—	—	—	—	—	—	—	—	—	×
Cassidulina cf. *laevigata*	—	—	—	—	—	—	—	—	—	×
Benthonic population in 10 gr	56	1130	912	666	550	880	688	1680	164	1170
Planktonic population in 10 gr	3	3	8	2	10	0	0	10	5	20

(NORMAN) and *Ammotium cassis* (PARKER) appear only in Fauna 3.

Fauna 3A is characterized by the predominance of *Nonionella stella* CUSHMAN & MOYER. *Eggerella advena* CUSHMAN is also dominant. *Epistominella tamana* (KUWANO), *Trochammina squamata stellata* HÖGLUND, *Textularia earlandi* PARKER, *Elphidium clavatum* CUSHMAN and *Buccella frigida* (CUSHMAN) are important members.

The boundary at *ca.* 75 m is tentative since only one sample is available to establish Fauna 3B. The boundary is based upon:

1) *Uvigerina cushmani* TODD, *Cassidulina nörvangi* THALMANN become dominant suddenly.
2) *Nonion labradoricum* (DAWSON), *Elphidium bartletti* CUSHMAN, *Quinqueloculina* sp. cf. *Q. elongata* and *Cassidulina* sp, cf. *C. laevigata* D'ORBIGNY, though the occurrences of them are rare, appear only in Fauna 3B.

Fauna 3B is represented by only one sample and more materials are necessary to ascertain this fauna. The deep limit of this fauna is unknown. The fauna is characterized by the abundance of *Uvigerina cushmani* TODD which is considered to be a deep water species. *Elphidium clavatum* CUSHMAN and *Eggerella advena* CUSHMAN are abundant as in Fauna 3A.

As is mentioned in the chapter on the hydrography, there is a distinct boundary at *ca.* 50 m in depth, and there is another boundary at *ca.* 25 m. These two boundaries appear to be well represented by benthonic Foraminifera assemblages. The boundaries also appear to be represented by planktonic organisms. MOTODA and ANRAKU (1952) studied the vertical distribution of plankton at the mouth of Funka Bay and found that warm-water species were concentrated in upper 30 m of water, *Paracalanus parvus*, a shallow-water copepod, disappeared at 50 m, and *Limacina helicina* began to appear at 30 m and suddenly became less abundant at 50 m. Thus physical (HIDAKA, 1934; UDA, 1938), chemical (MATSUDAIRA and MIZUUCHI, 1934) and biological (MOTODA and ANRAKU, 1952) data appear to support the results obtained by the writer in studying benthonic Foraminifera.

Interpretation of these Foraminifera assemblages or boundaries is, for the time being, difficult since the oceanographic data of this area is very scarce. The 20 m boundary may represent the base of the turbulent zone, or the base of the upper water which is, though apparently of Oyashio type, a mixture of Oyashio and Tsugaru Currents. The 50 m boundary may represent the base of the seasonal thermocline. The presence of such arenaceous species as *Haplophragmoides bradyi* (ROBERTSON), *Alveolophragmium crassimargo* (NORMAN) and *Ammotium cassis* (PARKER) in Fauna 3A and 3B suggests that the water mass deeper than *ca.* 50 m may represent the Intermediate Water.

Total benthonic population at Station 4 and 11 is much smaller than that at other stations. This is because the sediment at Station 4 is coarser than at other stations, and the sediment at Station 11 contains abundant pumice grains. In general it appears that the more pumice grains in sediment the less the benthonic population is.

Brief Taxonomic Notes

Elphidium planum HUSEZIMA & MARUHASI is a synonym of *Elphidium subarcticum* CUSHMAN.

Elphidium ezoense ASANO is a synonym of *Elphidium oregonense* CUSHMAN & GRANT.

Cribroelphidium arcticum TAPPAN is a synonym of *Elphidium bartletti* CUSHMAN.

Alveolophragmium ochotonensis STSCHEDRINA is a synonym of *Alveolophragmium crassimargo* (NORMAN).

Uvigerina cushmani TODD may be a synonym of *Uvigerina yabei* ASANO, but it is not sure.

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FLESHY ALCYONARIANS FROM SOUTHERN FORMOSA[1]

Huzio UTINOMI

Seto Marine Biological Laboratory, Sirahama

With 4 Text-figures

For a month from May to July, 1938, about twenty years ago, I made a collecting trip to Formosa (Taiwan) for investigating the coral reefs and littoral fauna, especially to collect the cirripeds and alcyonarians. A general sketch of the coastal fauna of southern Formosa was already given in Hiro (1939a), and the systematic and ecological accounts of the cirripeds were also given in Hiro (1939b).

In this paper is given only a systematic list of the fleshy alcyonarians collected mainly on the southern coasts of Formosa between 7th and 16th of June, 1938. Among them, some of the most interesting forms were described in detail in three former papers (Utinomi, 1950a, 1950b and 1951).

This study was supported by a grant-in-aid from the Japan Society for the Promotion of Scientific Research. I am indebted to Dr. Katura Oyama for information on the homonymies of *Sphaerella*.

I. List of the Alcyonarian Collection from Formosa

STOLONIFERA

Family Clavulariidae Hickson

1. *Clavularia racemosa* Utinomi, 1950

Occurrence: Kizan near Suô, northeastern coast of Formosa. June 29, 1938.

Found on the root of a green alga *Caulerpa racemosa* var. *clavifera* Weber van Bosse (Utinomi, 1950b, p. 44).

Previously recorded also from southern Japan (type locality—Tanabe Bay, Kii Province) (Utinomi, 1950b).

2. *Clavularia inflata* Schenk, 1896

Occurrence: Daizyubô, southern end of Formosa. June 14, 1938.

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[1] Contributions from the Seto Marine Biological Laboratory, No. 336.

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Luxuriant on dead coral blocks and rock in shallow tide-pools. In life, the rigid anthosteles, about 25–30 mm long, are brownish yellow and the fully expanded anthocodiae pale brownish in color.

Previously recorded from Great Barrier Reef (MACFADYEN, 1936), East Indies (SCHENK, 1896; THOMSON and DEAN, 1931 as *Hicksonia köllikeri* DEAN), Philippines (MAY, 1900; ROXAS, 1933a, as *Clavularia inflata* var. *luzoniana* MAY), Tokara Islands (UTINOMI, 1953) and Ponape Island, Caroline group (UTINOMI, 1956).

3. *Pachyclavularia violacea* (QUOY & GAIMARD, 1833)

Occurrence: Daizyubô, southern end of Formosa. June 14, 1938.

Luxuriant in shallow tide-pools. The colonies of extraordinary appearance are bright reddish purple in colour. In life, the color of the anthocodiae fully extended is ocher red, though pale cinnamon pink around the central mouth. The neck portion below the tentacles extended out of the red anthostelar portion is only brownish.

Previously recorded from Vanikoro, Santa Cruz Islands (type locality) (QUOY & GAIMARD, 1833 as *Clavularia violacea*), East Indies (ROULE, 1908; THOMSON & DEAN, 1931, as *Pachyclavularia erecta* ROULE), Philippines (ROXAS, 1933 a, as *P. erecta*), Great Barrier Reef (MACFADYEN, 1936, as *P. erecta*) and Titizima, Bonin Islands (UTINOMI, 1956). For synonymies see GOHAR, 1940.

Family Tubiporidae GRAY

4. *Tubipora musica* LINNAEUS, 1758

Occurrence: Garanbi, southernmost cape of Formosa. June 13, 1938.

Overgrown on coral shingles in tide-pools. This well-known "organ-pipe coral" is very common around the frinzing reefs of southern Formosa, but the color of living polyps when expanded may mislead its occurrence there, since the tentacles are apparently either pale cinnamon pink, olive yellow or glaucous green and the polyp stalk brown uniformly (according to my field note).

Widespread in all tropical Indo-Pacific Ocean from Red Sea to Australia.

ALCYONACEA

Family Xeniidae VERRILL

5. *Anthelia formosana* UTINOMI, 1950

Occurrence: Garanbi, southernmost cape of Formosa. June 13, 1938.

Luxuriant in tide-pools under the light house. When alive, they are uniformly bluish white, basal membrane spreading over sponges or other solid substratum with numerous, non-pulsating, polyps close together (UTINOMI, 1950a, p. 82).

6. *Heteroxenia elisabethae* KÖLLIKER, 1875

Occurrence: Garanbi, southernmost cape of Formosa. June 13, 1938.

Abundant in tide-pools south and west of the light house (UTINOMI, 1950a, p. 85).

Previously recorded from East African coast, Great Barrier Reef, East Indies, Philippines (HICKSON, 1931; ROXAS, 1933a).

7. *Cespitularia stolonifera* GOHAR, 1938

Occurrence: Garanbi, southernmost cape of Formosa. June 12, 1938.

A large branched colony was found in a tide-pool south of the light house. *Caphyra*- or *Lissocarcinus*-like small crabs were found commensally between polyps (UTINOMI, 1950a, p. 90).

Previously recorded from Amboina by WRIGHT & STUDER (1889) as *Xenia elongata* DANA (cf. GOHAR, 1938, p. 483).

Family Asterospiculariidae UTINOMI

8. *Asterospicularia laurae* UTINOMI, 1951

Occurrence: Daizyubô. June 14, 1938.

This unique alcyonarian with stellate spicules alone is seemingly a branched colony with a few mushroom-like lappets covered by a number of monomorphic polyps lacking pinnules on tentacles (UTINOMI, 1951).

Family Alcyoniidae LAMOUROUX

9. *Sinularia polydactyla* (EHRENBERG, 1834)

(Fig. 1, *a–b*)

Occurrence: Ryûkyûsyo (Lambay Island). June 8, 1938.

Growing to large size, brown or gray in color, with stout laterally flattened lobes. Widely distributed in Indo-Westpacific tropical shallow waters.

10. *Sinularia mayi* LÜTTSCHWAGER, 1915

(Fig. 1, *c–e*)

Occurence: Daizyubô. June 14, 1938.

Abundant on reef edges. Colonies rather low (about 7 cm high in alcohol specimens), grayish white in color. In one colony a gastropod *Rapa rapa* (LINNAEUS) was found as embedded wholly in the bark of the stalk.

Previously recorded from East Indies, Philippines (LÜTTSCHWAGER, 1915; ROXAS, 1933b) and Indochina (TIXIER-DURIVAULT, 1945).

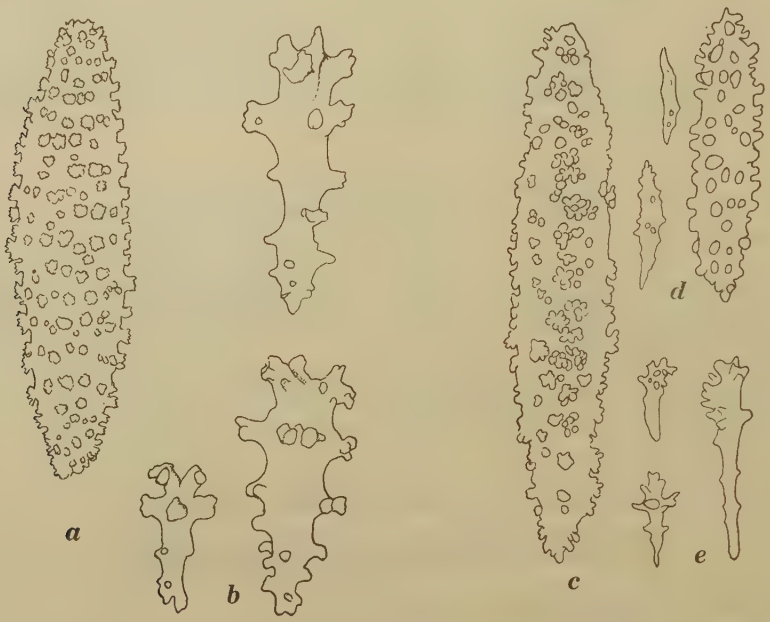

Fig. 1. *a–b*. *Sinularia polydactyla* (EHRENBERG).
a, coenenchymal spicule; *b*, cortical spicules.
c–e. *Sinularia mayi* LÜTTSCHWAGER.
c, *d*, coenenchymal spicules; *e*, cortical spicules.
(*a*, *c*, *d*×18; *b*×150; *e*×75)

11. *Sarcophyton ehrenbergi* MARENZELLER, 1886

Occurrence: Daizyubô. June 14, 1938.

One colony with feebly folded cup-shaped disc, about 6 cm across, was collected. Widely distributed in tropical Indo-Westpacific waters (TIXIER-DURIVAULT, 1958).

12. *Sarcophyton acutangulum* (MARENZELLER, 1886)

Occurrence: Daizyubô. June 14, 1938.

One colony with the disc, 3.5 cm×5.4 cm in size, strongly folded into high folds slightly projecting from the stalk, was collected. Autozooids in the center of the disc are as usual raised as mounds and about 3 mm apart.

Widespread in tropical Indo-Westpacific, as far north as Kii coast of southern Japan (UTINOMI, 1954a, 1956).

13. *Sarcophyton moseri* ROXAS, 1932

Occurrence: Daizyubô. June 14, 1938.

One small colony with 3 cm high stalk and unfolded disc, about 2.2 cm×3.2 cm in size, was collected.

Previously recorded from Philippines (ROXAS, 1932, 1933b), New Caledonia (TIXIER-DURIVAULT, 1946, 1958) and Tokara Islands, southern Japan (UTINOMI, 1953).

14. *Sarcophyton glaucum* (QUOY & GAIMARD, 1833)

(Fig. 2)

Occurrence: Daizyubô. June 14, 1938.
Ryûkyûsyo. June 7, 1938.

Common in shallow waters near reef edges.

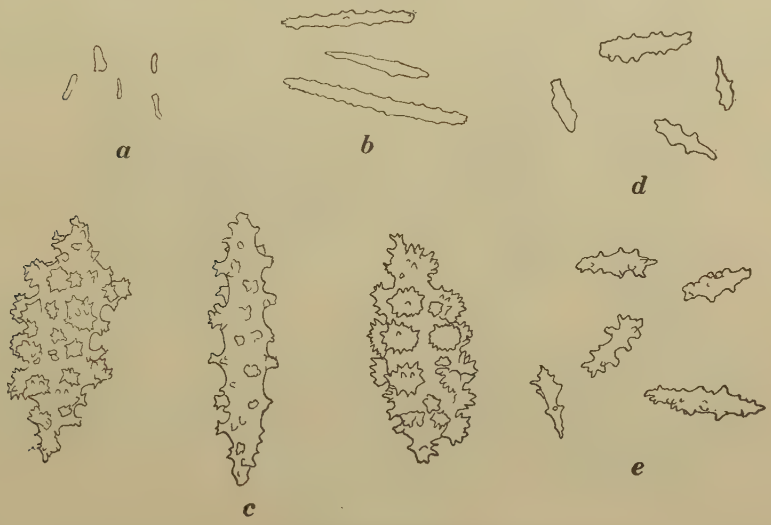

Fig. 2. *Sarcophyton glaucum* (QUOY & GAIMARD).
a, tentacle spicules; *b*, coenenchymal spicules of capitular disc; *c*, coenenchymal spicules of stalk; *d*, cortical spicules of capitular disc; *e*, cortical spicules of stalk. (All ×100)

Largest one among many specimens brought home measures about 10 cm across and 5 cm high in alcohol.

Widespread in tropical Indo-Westpacific (MOSER, 1919, p. 253; TIXIER-DURIVAULT, 1958). Not ever found in Japan proper.

15. *Sarcophyton tropheliophorum* (MARENZELLER, 1886)

Occurrence: Daizyubô. June 14, 1938.

Common on reef edges. In one specimen collected there, the disc is 3 cm×4 cm in size and strongly convoluted at margins into 8 thick main folds.

Widespread in the Indo-Westpacific, as far north as Tokara Islands (UTINOMI, 1953, p. 231; TIXIER-DURIVAULT, 1958).

16. *Cladiella sphaerophora* (EHRENBERG, 1834)

(Fig. 3)

Occurrence: Daizyubô. June 14, 1938.

Two small cerebriform grayish white colonies were collected. One of them figured here is 29 mm×33 mm in size and 15 mm in height. Its basal attachment is 15 mm×20 mm and flattened.

Polyps are very minute, thickly set on roundly constricted lobes, and they are about 0.5–0.7 mm apart. Cortical spicules are tuberculate capstans with distinct median waist and covered by many rounded tubercles. They are about 0.07–0.09 mm long and 0.04–0.05 mm wide. Besides, smaller discs, about 0.02 mm×0.04 mm, are found.

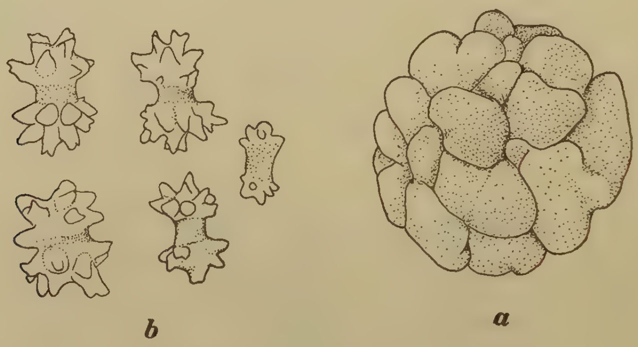

Fig. 3. *Cladiella sphaerophora* (EHRENBERG).
a, compressed colony, upper view; *b*, cortical spicules of lobes.
(*a*×1; *b*×150)

Previously recorded from Red Sea (EHRENBERG, 1834; KLUNZINGER, 1877; TIXIER-DURIVAULT, 1948), Madagascar, Seychelles, East African coast, Tahiti, East Indies and Bonin Islands (UTINOMI, 1956).

17. *Cladiella pachyclados* (KLUNZINGER, 1877)

Occurrence: Daizyubô. June 14, 1938.

Common on reef edges. Colonies grayish in color, with low finger-like lobes not so much compressed as in *C. sphaerophora*.

Widespread in Indo-Westpacific tropical waters (KLUNZINGER, 1877; MACFADYEN, 1936; TIXIER-DURIVAULT, 1948).

Family Nephtheidae VERRILL

18. *Paralemnalia thyrsoides* (EHRENBERG, 1834)

Occurrence: Garanbi. June 12, 1938.

Two fine colonies, brownish in life, with retractile polyps all over the finger-like lobes up to 6 cm long, were collected.

Previously recorded from Red Sea, Indian Ocean, East Indies, Philippines, Great Barrier Reef and Palau Islands (UTINOMI, 1956).

19. *Nephthea erecta* KÜKENTHAL, 1903

Occurrence: Daizyubô. June 14, 1938.

Previously recorded from Tonga Islands, East Indies, Philippines and Kii coast, southern Japan (UTINOMI, 1954b).

COENOTHECALIA

Family Helioporidae MOSELEY

20. *Heliopora coerulea* (PALLAS, 1766)

Occurrence: Daizyubô. June 14, 1938.

Only a dead fragment of the colony was obtained.

Widespread in tropical Indo-Westpacific, as far north as Tokara Islands, southern Japan (UTINOMI, 1953, 1956).

GORGONACEA

SCLERAXONIA

Family Briareidae GRAY

21. *Solenopodium marquesarum* (KÜKENTHAL, 1916)

(Fig. 4)

Occurrence: Daizyubô. June 14, 1938.

A hump-shaped colony with a hollow center was collected. It is about 3 cm long and 3.5 cm wide. The outer surface is dull grayish brown, while the inner surface is beautifully violet. The outer cortical spicules are all colorless tuberculate spindles, while those of the inner medulla are violet-colored, more slender spindles or irregularly branched forms.

This species was originally assigned to the genus *Erythropodium* (Kükenthal, 1916, 1919 and 1924), but later transferred to the genus *Solenopodium* by Molander (1929, p. 39), Aurivillius (1931, p. 9), Macfadyen (1936, p. 67) and Stiasny (1937, p. 15), though the former three authors consider as an encrusting form of the more branched cylindrical species *S. stechei* (Kükenthal).

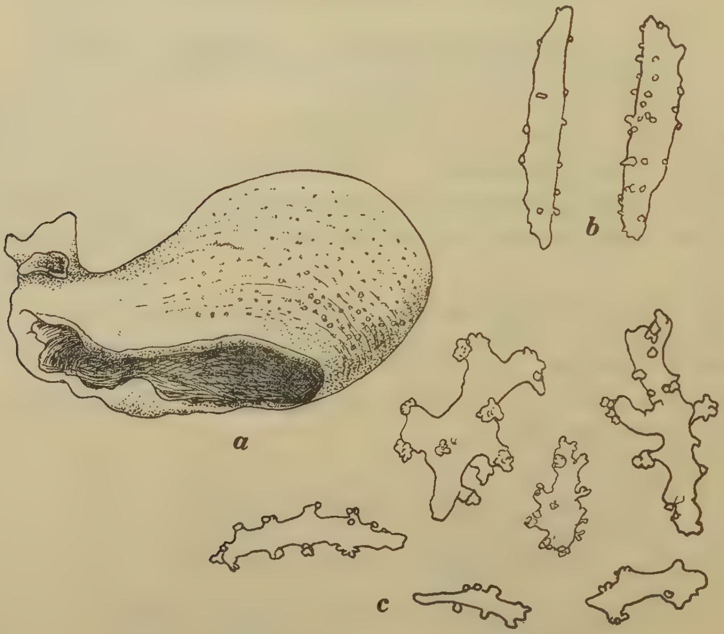

Fig. 4. *Solenopodium marquesarum* (Kükenthal).
a, hump-shaped colony; *b*, cortical spicules of outer layer, colorless; *c*, cortical spicules of inner layer, violet colored. (*a* ×1; *b*, *c* ×60)

Previously recorded from Marquesas Islands, Timor and Low Isles (Stiasny, 1937, pp. 9–19).

II. Proposal of using Gray's *Cladiella* instead of his *Sphaerella*

For the Indo-Pacific encrusting alcyoniids having exclusively very small capstan-formed spicules and minute finger-biscuit-like discs in the coenenchymes Bayer (1955, p. 207) proposed to adopt the oldest genus name *Sphaerella* (Gray, 1869, p. 122; genotype—*Alcyonium tuberculosum* Quoy & Gaimard), because the name was earlier erected than *Microspicularia* Macfadyen (1936, p. 28; genotype -*Alcyonium pachyclados* Klunzinger). Tixier-Durivault (1957) also revived that name.

Regret to say, however, this genus name is preoccupied by *Sphaerella* SOMMERFELT 1824 (=*Haematococcus* AGARDH) of the Flagellata (Protozoa) and also by *Sphaerella* CONRAD 1838 and 1860 of the fossil Lamellibranchia (Mollusca), as pointed out by NEAVE (1940, vol. IV, p. 238 and CHERBONNIER, 1958). Another genus name *Cladiella* erected by GRAY (1869, p. 125) is thus a subjective junior synonym of *Sphaerella* GRAY.

GRAY erected *Cladiella* for two species *Lobularia sphaerophora* EHRENBERG 1834 and *Alcyoninm brachycladium* DANA 1846 (=*Lobularia brachyclados* EHRENBERG 1834), but failed to indicate a type species. Therefore, I hereby propose to revive this *Cladiella* as the next available genus name and to designate *L. spherophora* EHRENBERG as the type of *Cladiella*. For this genus MACFADYEN's definition of the genus *Microspicularia* (1936, p. 29) is wholly applicable.

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A NEW GALL-FORMING BARNACLE IMBEDDED IN THE BARK OF A GORGONACEAN COLONY (*ACASTA GREGARIA* N. SP.)[1]

Huzio UTINOMI

Seto Marine Biological Laboratory, Sirahama

With Plate XXV and 2 Text-figures

As was reviewed by me (Hiro, 1937 b, p. 449), the cirriped genus *Acasta* inhabits sponges or octocorals semiparasitically and a number of species are known in the Indo-West Pacific waters. Of these, several ones are hitherto known living in the coenenchymes of octocorals either invariably or occasionally.

As imbedded in the coenenchyme of Alcyonacean group, the following 3 species are hitherto known:

1) *Acasta sculpturata* Broch (Broch, 1931, p. 101)
   Java Sea. Host name not given.
2) *Acasta echinata* Hiro (Hiro, 1937 a, p. 70; Broch, 1947, p. 23; Utinomi, 1949, p. 32)
   Kyusyu (Tomioka) and Indochinese coast (Condor Is.). Host: *Dendronephthya.*
3) *Acasta alcyonicola* Utinomi (Utinomi, 1953, p. 142)
   Honsyu (Kusimoto and Tanabe Bay). Host: *Nephthea crassa* Kükenthal[2].

As imbedded in the bark of the Gorgonacean group, the following 3 species are hitherto known:

4) *Acasta purpurata* Darwin (Darwin, 1854, p. 318)
   Sumatra and Philippine Archipelago. Host: *Isis.*
5) *Acasta hirsuta* Broch (Broch, 1916, p. 10; Broch, 1931, p. 96)
   West Australia (Cape Jaubert) and Malay Archipelago (Amboina Bay). Host: *Euplexaura.*
6) *Acasta spinitergum* Broch (Broch, 1931, p. 112)
   Malay Archipelago (off Samalona, Makasser and Java Sea). Host name not given.

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[1] Contributions from the Seto Marine Biological Laboratory, No. 337.

[2] Originally mentioned as "*Capnella* and *Nephthea*".

Publl. Seto Mar. Biol. Lab., VII (3), 1959. (Article 19)

Recently through the courtesy of Mr. Torao YAMAMOTO, I have had an opportunity to examine a new member referable to this group, as describing in the following text.

I am greatly indebted to Mr. Torao YAMAMOTO for placing the specimens of barnacles and their host coral at my disposal and also to Dr. Isamu YAMAZI of our Laboratory for preparing a photograph of an *Acasta*-carrying gorgonacean colony.

Acasta gregaria sp. nov.

(Figs. 1 and 2)

Occurrence: Tanabe Bay, Prov. Kii, Japan. Depth unknown. April 3, 1959. T. YAMAMOTO *leg.*

Material: Preserved in the collections of the Seto Marine Biological Laboratory, as designated Type 176a (holotype), 176b (paratypes) and 177 (paratypes).

Description: The specimens are abundantly imbedded wholly in the bark of a flabellate colony of the genus *Euplexaura*. The host colony is allied to *E. anastomosans* BRUNDIN in the spiculation, but may be an undescribed species.

The barnacles are gregarious all round the branches of *Euplexaura*, forming polypiferous "galls" (see PLATE XXV). Owing to the very intimate adherence to the tough spiculiferous coenenchymes and the brittleness of shell plates, it is impossible to detach intact specimens of the cirriped.

The whole shell detached is ivory white, with pinkish hue upwards. It is, when complete, sub-globular in shape and oval in outline of the basal cup.

The basal cup is moderately shallow, but not prolonged in the carino-rostral axis and not directly attached to the horny axis of the host gorgonid. It is rather fragile and exhibits a structure of concentric, alternating hyaline and less transparent white rings. No canaliculation is found at all The upper edge is generally smooth, so that the basal cup may be easily detachable from the compartments.

The largest specimen measures about 6 mm in carino-rostral diameter. The total height slightly exceeds the carino-rostral diameter.

The compartments are also thin and weakly connected with one another by radii and alae. On the external surface the parietes are furnished with many downturned calcareous spines. These spines are irregularly arranged all over the surface. They are generally short, bluntly tipped and empty internally. The internal side of the parietes is furnished with prominent but narrow longitudinal ribs below the sheath which is longer than the lower wall.

The radii and alae are broad and have straight upper margin very oblique to the basal margin of the parietes.

The rostrum is the widest of all compartments, nearly erect; its basal width is about two-thirds of its own length.

The carinal latus is very narrow, about one-seventh as wide as the carina. The carina is about three-fifths as wide as the rostrum and about two-thirds of its own length.

The scutum is rather thick, higher than wide, and has strongly crenated and beaded growth-ridges as crossed by close radiating (longitudinal) furrows. On the internal surface a broad and deep pit for the adductor muscle is distinctly indicated. It is clearly separated from the articular ridge by a slight longitudinal furrow extending down to a shallow depression for the lateral depressor muscle. The articular furrow is wide and deep.

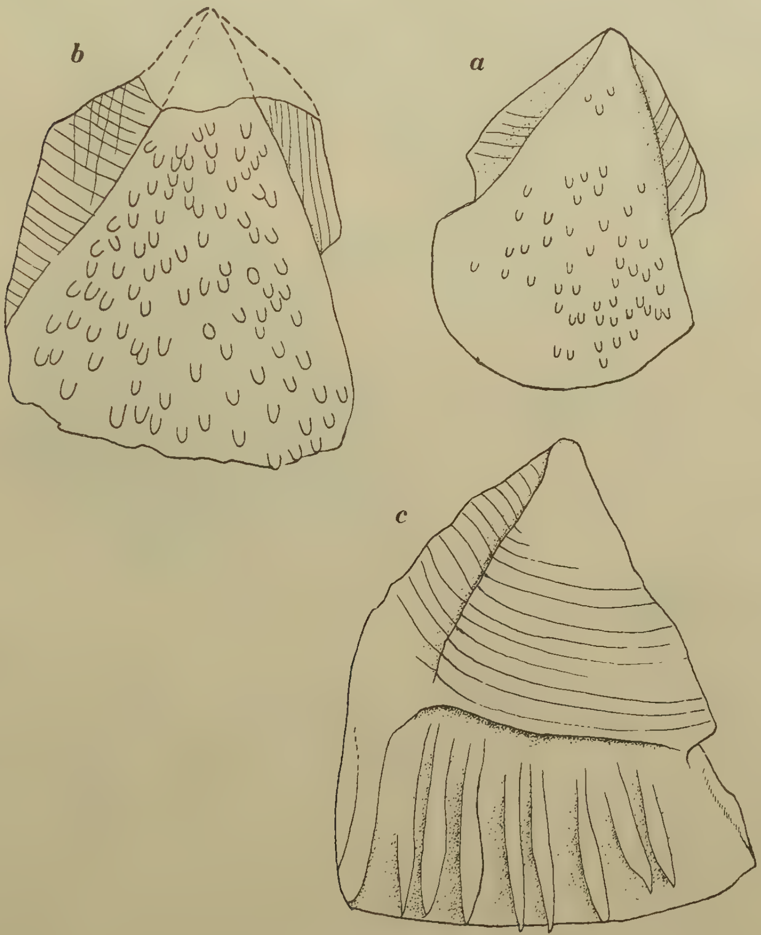

Fig. 1. *Acasta gregaria* n. sp.
a External side of carina, *b* external side of lateral compartment, *c* internal side of lateral compartment. All ×18.

The tergum is rather thin and a little longer than wide. The apex is not beaked. The upper (carinal) margin is nearly straight and subequal to the scutal margin in length. The carinobasal corner is angular, forming an angle of about 70°. The spur is short and wide, about one-half of the basal margin of the valve, and truncated at the end. A broad but shallow spur-fasciole runs from the apex to the end of the spur. On the external surface, the growth-ridges are generally smooth but slightly crenated towards the carinal margin. The internal surface is flattened, generally

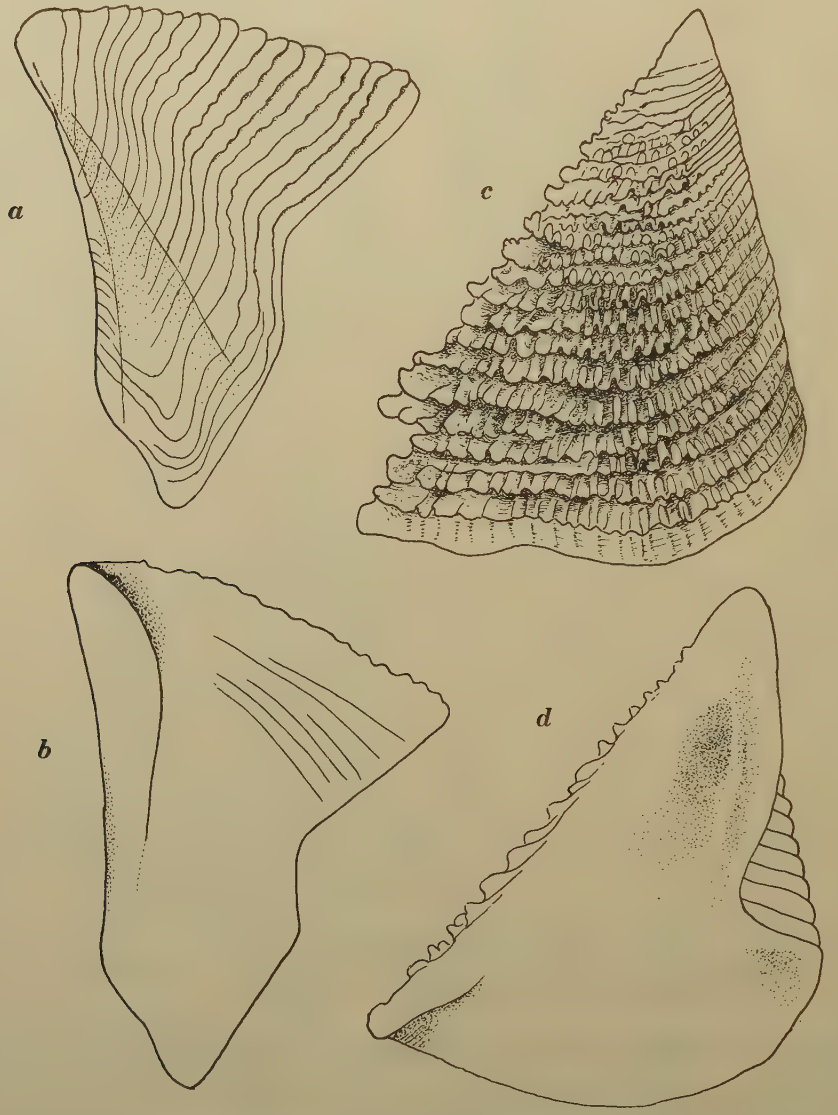

Fig. 2. *Acasta gregaria* n. sp.
a External side of tergum, *b* internal side of tergum, *c* external side of scutum, *d* internal side of scutum. All ×33.

smooth, but a few long crests for the depressor muscles (6–7 in number) are feebly indicated.

The internal body could not be studied as all specimens were dried before examination.

Remarks: The present species is doubtless nearly allied to *Acasta hirsuta* BROCH (1916) by its general appearance and its habitat as occurring in the bark of *Euplexaura* colony. It is also allied to *A. spinitergum* BROCH (1931) and *Balanus* (*Conopea*) *fragilis* BROCH (1931) in the structure of the opercular valves. But, it may be distinct from these allies as indicating by the cup-formed basis, the more strongly cancellated scutum and the non-beaked tergum, even if the internal anatomy is not examined.

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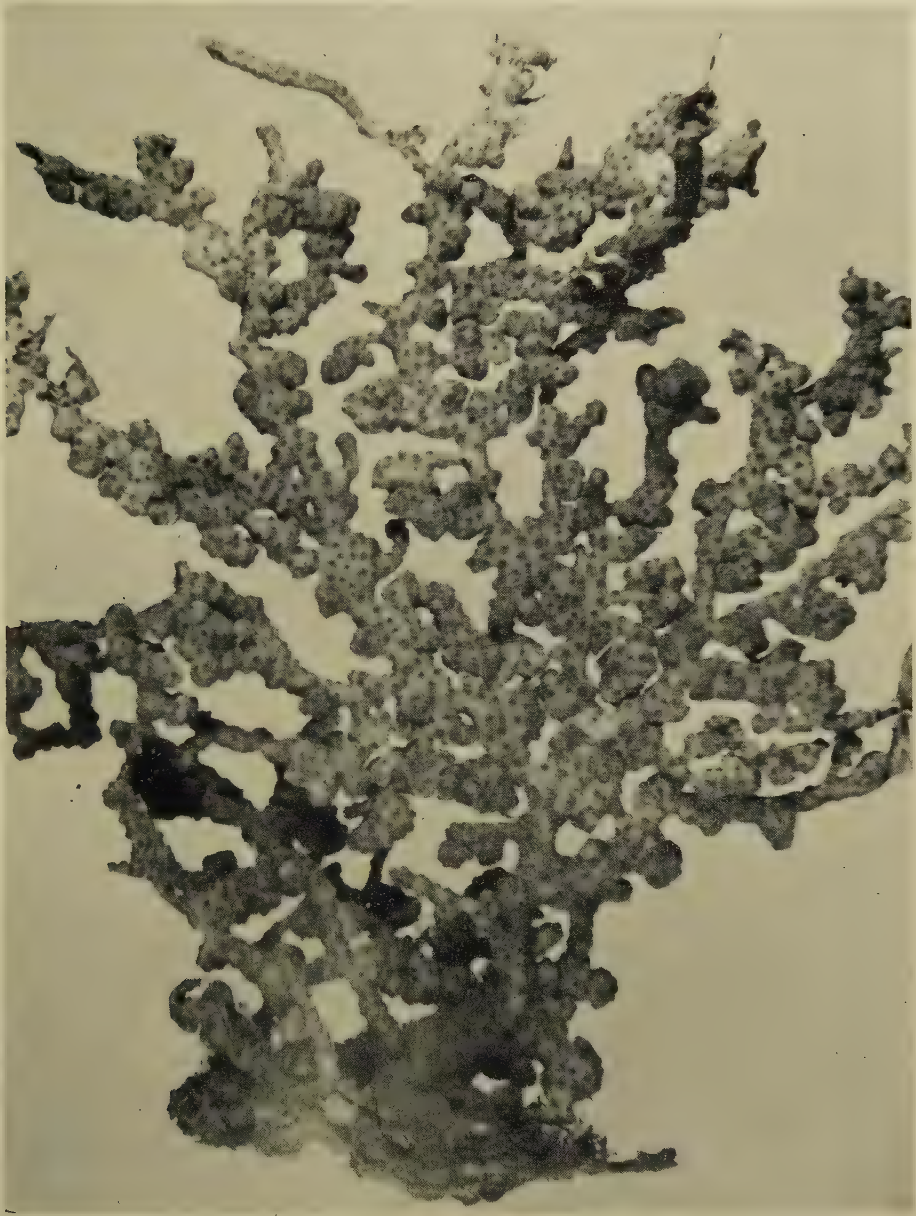
EXPLANATION OF PLATE XXV

Photograph of a flabellate colony of *Euplexaura* sp. parasitized by a number of the barnacle *Acasta gregaria* n. sp. Natural size.



H. UTINOMI: A NEW GALL-FORMING BARNACLE (*Acasta gregaria* n. sp.).

STUDIES ON THE HELMINTH FAUNA OF JAPAN

PART 55. FOUR NEW GENERA OF ACANTHOCEPHALA FROM FISHES

SATYU YAMAGUTI

Department of Parasitology, Okayama University
Medical School, Okayama

With Plate XXVI

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ECHINORHYNCHIDAE COBBOLD, 1879

1. *Metacanthocephalus pleuronichthydis* n. g., n. sp.

(Pl. XXVI, Figs. 1–3)

Habitat: Small intestine of *Pleuronichthys cornutus* (TEMM. et SCHLEG.)

Material: 15 mature males and 23 mature or gravid females.

Locality and date: Inland Sea; September 9, 1957.

Male. Proboscis subcylindrical, broadly rounded in front, 0.43–0.5×0.27–0.4 mm, with 21–26 longitudinal rows of 7–10 hooks each; largest subapical hooks 62–78μ long; smallest basal hooks 41–55μ long. Neck very short. Proboscis sheath subcylindrical to claviform, double-walled, 0.7–1.0×0.28–0.4 mm, with ganglion at its anterior end. Lemnisci fattened, usually longer than proboscis sheath, up to 1.0–1.2 mm long when extended. Trunk subcylindrical, 5.0–6.5×0.7–1.0 mm, with numerous, small, partly branched, hypodermal nuclei. Testes rounded, directly tandem, in midregion of trunk or more or less posterior to it; anterior usually longer than wide, 0.4–0.6×

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0.26–0.5 mm, posterior wider than long, 0.25–0.44×0.33–0.6 mm. Seminal vesicle subglobular, situated between Säfftigen's pouch and bursa, 0.26–0.42×0.2–0.4 mm. Cement glands 8, claviform, with their swollen ends close together between posterior testis and Säfftigen's pouch. Säfftigen's pouch 0.3–0.5 mm in diameter. Paired diverticles of muscular bursal cap about 0.17 mm in diameter; bursal rays short, numerous, folded. Genital pore terminal.

Female. Proboscis subcylindrical, 0.45–0.6×0.3–0.4 mm, with 23–30 longitudinal rows of 8–10 hooks each; largest subapical hooks 65–78μ long, smallest basal hooks 39–62μ long. Neck very short. Proboscis sheath cylindrical or subcylindrical, 1.1–1.7×0.2–0.32 mm. Lemnisci 1.3–2.0 mm long in extended condition. Uterine bell more or less elongated goblet-shaped, 0.14×0.1 mm in the type 16.5 mm long. Uterus divided into two portions of different structure, the anterior portion (0.18×0.07 mm in the type) appears as if it were telescoped into the posterior portion, which is cylindrical, 0.18×0.08 mm in the type, and contains medullary tissue between the inner lining and the outer muscular capsule. Vaginal funnel enclosed in uterus, its posterior portion lying outside the uterus, surrounded by a sphincter, which in turn is enclosed in the outer sphincter of spiral bands; vaginal bulb opening terminally, 0.11 mm in diameter. As measured in life the elongate elliptical outer egg shell is 77–81μ long by 13μ wide, the middle shell with polar prolongations 60μ long and the inner shell 54–56μ long.

This genus is characterized by the anterior position of the ganglion and the number of the cement glands, though agreeing in other characters with *Acanthocephalus.*

Metacanthocephalus n. g.

Generic diagnosis.—Echinorhynchinae of medium size. Trunk subcylindrical, with numerous, small, partly branched, hypodermal nuclei. Lacunar system reticular. Proboscis subcylindrical, with numerous longitudinal rows of several hooks each. Neck short. Proboscis sheath cylindrical to claviform, long, double-walled, with ganglion at its anterior end. Lemnisci elongate, usually longer than proboscis sheath. Testes rounded, directly tandem, in midregion of trunk or a little behind it. Cement glands 8, compact, close together between posterior testis and Säfftigen's pouch. Säfftigen's pouch and seminal vesicle well developed. Muscular cap of bursa with anterior diverticula, provided posteriorly with numerous short folded rays. Uterine bell goblet-shaped; vagina with an outer and an inner sphincter. Egg elongate elliptical, with polar prolongations of middle shell. Parasitic in marine teleosts.

Genotype: *M. pleuronichthydis* n. sp.

2. *Metacanthocephaloides zebrini* n. g., n. sp.

(Pl. XXVI, Figs. 8–10)

Habitat: Small intestine of *Zebrias zebrinus*, *Inegocia meerdervoorti*, *Pleuronichthys cornutus* and *Paralichthys olivaceus.*

Material: 15 males and 30 females, more or less contracted, from first host, 6 males and 20 females from second host, one male and two females from third host, and three females from fourth host; all mature but not fully gravid.

Locality and date: Inland Sea of Japan; April 29, 1957.

Male. Trunk cylindrical, 2.0–2.3 mm in length, with maximum breadth of 0.5 mm; hypodermic nuclei small, numerous, partly branched. Lacunar system reticular. Neck short. Proboscis ovoid to subcylindrical, more or less swollen near middle, 0.3–.5× 0.12–0.28 mm; proboscis hooks in 23–25 longitudinal[1] rows of 6–9 hooks each; largest subapical hooks with short backwardly directed root, up to 56–78μ long; smallest basal hooks 39–52μ long. Proboscis sheath subcylindrical, double-walled, 0.4–0.75 mm (0.9 mm when fully extended) long by 0.1–0.2 mm broad, reaching to anterior testis; elliptical ganglion situated at or near anterior end of proboscis sheath. Lemnisci claviform or cylindrical, usually a little shorter than proboscis sheath. Testes subglobular to ovoid, directly tandem in anterior half of trunk, 0.2–0.5×0.24–0.52 mm; sometimes occupying whole breadth of trunk cavity. Seminal vesicle well developed, 0.15–0.28×0.1–0.23 mm, situated obliquely immediately anterior to muscular cap of bursa. Cement glands 6, compact, irregular in shape, massed together immediately behind posterior testis. Bursal cap without paired anterior diverticula, provided at its posterior border with a number of short lobular projections. Non-muscular portion of bursa (bursa proper) provided inside with numerous small tubercles, constricted posteriorly by sphincter-like muscle bundles, and opening terminally by wide aperture.

Female. Trunk 3.0–5.5×0.5–0.7 mm, with numerous, small, partly branched, hypodermal nuclei. A short neck present. Proboscis subcylindrical, more or less swollen toward middle; 0.4–0.6×0.24–0.26 mm; proboscis hooks in 23–28 longitudinal rows of 7–10 hooks each. Proboscis sheath elongate, 0.6–0.9 mm (1.1 mm when fully extended) long by 0.13–0.23 mm broad, with ganglion at its anterior end. Lemnisci a little shorter than proboscis sheath. Uterine bell with comparatively narrow aperture, dilated posteriorly (about 40μ wide), 0.44 mm in length combined with uterine duct. Uterus proper 0.2×0.06 mm, enclosing vaginal funnel posteriorly. Vaginal bulb 0.12 mm in diameter, opening into terminal sinus, which is about 0.3 mm deep in the type. On each side of the vagina is a very conspicuous two-lobed giant cell *sui generis* measuring 0.15–0.18×0.11–0.13 mm and containing very finely granular protoplasm and a large round nucleus about 25μ in diameter; it is enclosed in a thick (5–10μ) capsule of homogeneous structure and situated a little obliquely with its base directly on the anterolateral part of the vaginal bulb. Immature eggs scattered diffusely in cavity of trunk, no mature eggs observed.

The present genus resembles *Metacanthocephalus* very closely, but differs from it in the number of cement glands and in the presence of a peculiar giant cell on each side of the vagina. The latter structure has never been observed in any acanthocephalans so far as I am aware.

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[1] 19 longitudinal rows in the male from *Pleuronichthys cornutus*.

Metacanthocephaloides n. g.

Generic diagnosis. Echinorhynchinae of submedium size. Trunk cylindrical, with numerous, small, partly branched, hypodermal nuclei. Lacunar system reticular. Neck short. Proboscis ovoid to subcylindrical, with numerous (23–28) longitudinal rows of several hooks each; hooks becoming gradually larger from apex toward middle of proboscis and thence gradually smaller, attaining minimum length at base. Proboscis receptacle long, double-walled, with ganglion at its anterior end. Lemnisci digitiform or claviform, not very long. Testes rounded, directly tandem, pre-equatorial. Cement glands 6, compact, close together behind posterior testis. Säfftigen's pouch and seminal vesicle well developed. Muscular cap of bursa without anterior diverticula, provided posteriorly with a circle of short lobular appendages. Uterine bell not gaping anteriorly. On each side of the vagina is a very conspicuous, mononuclear, giant cell of unknown nature. Eggs? Parasites of marine teleosts.

Genotype: *M. zebrini* n. sp.

RHADINORHYNCHIDAE TRAVASSOS, 1923

3. *Metarhadinorhynchus lateolabracis* n. g., n. sp.

(Pl. XXVI, Figs. 4–7)

Habitat: Small intestine of *Lateolabrax japonicus* (TEMM. et SCHLEG.)

Material: One mature male and two young females.

Locality and date: Inland Sea; September 9, 1957.

Male. Proboscis claviform, about 0.43 mm long by 0.17 mm broad near apex, with 23 longitudinal rows of about 20 hooks each¹⁾; hooks increasing in size from the apex toward the broadest subapical region, where they are stout and measure 54–56μ long, and whence they gradually decrease in size toward the base of the proboscis, attaining a minimum length of about 25μ. Neck short trapezoidal. Proboscis sheath approximately fusiform, 0.85×0.24 mm, double-walled; ganglion nearly equatorial. Retinacula leaving proboscis sheath behind its middle. Lemnisci filiform, winding, reaching far beyond base of proboscis sheath. Trunk long, slender, cylindrical, 13.5 mm by 0.57 mm in moderately contracted state; somewhat tapering anterior part covered all round for a distance of 0.3 mm with spines which are 23–40μ long, imbedded in the cuticular folds and arranged nearly in quincunx; no separate group of spines elsewhere. Hypodermal nuclei small, numerous; lacunar system reticular.

Testes elongated elliptical, tandem near anterior end of trunk, partly overlapping each other, anterior measuring 0.95×0.28 mm and posterior 0.76×0.25 mm. Vesicula seminalis elongate fusiform, 0.13 mm wide, posteroventral to Säfftigen's pouch. Cement

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1) The exact number of the hooks in each row is unable to make out owing to the proboscis being invaginated at the apex.

glands 8 in number, very long and filiform, massed together on each side into a bundle and then forming a smollen duct 0.2 mm wide at attenuated posterior portion of Säfftigen's pouch. Säfftigen's pouch elongate, nearly 1 mm long, forming a bulbous dilatation 0.37 mm in diameter at about middle, whence it tapers abruptly both backwards and forwards. Muscular cap of bursa with paired anterior diverticles as usual; posterior bursal rays not well differentiated. Between the bursa and the terminal genital pore is a large sphincter about 0.2 mm in diameter.

Female. Proboscis claviform, about 0.45–0.5 mm long, 0.24–0.27 mm wide at subapical swelling, with 23–25 longitudinal rows of about 20 hooks each; largest subapical hooks 52–65μ long, smallest basal hooks 31μ long. Neck 0.15–0.16 mm long. Proboscis sheath elongate elliptical, 0.75–0.9×0.29 mm, with its double-layered wall perforated by retinacula behind its middle; ganglion pre-equatorial. Lemnisci tubular, long, crumpled. Trunk 13.7–22 mm long by 0.6–0.9 mm broad in contracted state; its anterior end attenuated and covered in quincunx with alate spines 26–47μ long as in male for a distance of 0.25–0.3 mm. Germ cells forming masses of varying dimensions, some of them scattered, others packed together in posterior part of trunk. Uterus tubular very long. The vagina distinctly divided into two bulbous portions; in the type the anterior bulb corresponding to the vaginal funnel is 52μ long by 47μ broad, and the elliptical posterior bulb 65μ long by 36μ broad. There are two vaginal sphincters; the anterior, 59μ in diameter in the type, surrounds the constricted part of the vagina, and the posterior, 55μ in diameter, surrounds the posterior end of the vagina and rests on the terminal vaginal bulb which is 65μ in diameter. Vulva subterminal, about 0.4 mm from the blunt tail end. Eggs not yet developed.

This genus, apparently belonging to the family Rhadinorhynchidae, is related to *Rhadinorhynchus* LÜHE, 1911, but differs from it in possessing 8 cement glands.

Metarhadinorhynchus n. g.

Generic diagnosis.—Rhadinorhynchidae. Trunk cylindrical or subcylindrical, with numerous, small, hypodermal nuclei, covered anteriorly with spines which are imbedded in cuticular folds and arranged in quincunx, forming a single continuous group. Proboscis somewhat claviform, with numerous longitudinal rows of hooks which increase in size from the apex of the proboscis down to the broadest subapical region and then decrease toward the base; basal spines the smallest and not projecting very prominently. Neck short. Proboscis sheath fusiform to elongate elliptical, double-walled, with ganglion near its middle. Lemnisci slender, long. Testes tandem, contiguous, in anterior third of trunk. Seminal vesicle elongate. Cement glands 8, tubular, very long, forming paired elongate réservoirs posteriorly, one on each side of seminal vesicle and attenuated posterior portion of Säfftigen's pouch. Uterus tubular, very long; vagina divided into two bulbous portions, anterior bulb representing the vaginal funnel; two (an anterior and a posterior) vaginal sphincters and terminal vaginal bulb present; vulva subterminal. Eggs ? Parasitic in marine teleosts.

Genotype: *M. lateolabracis* n. sp.

4. *Allorhadinorhynchus segmentatum* n. g., n. sp.

(Pl. XXVI, Figs. 11–13)

Habitat: Small intestine of *Hyporhamphus sayori* (TEMM. et SCHLEG.)

Material: Two mature males and two gravid females.

Locality and date: Inland Sea; September 13, 1957.

Male. Trunk subcylindrical, 1.8–2.1 mm in length, with maximum width of 0.24–0.3 mm at level of Säfftigen's pouch or muscular bursal cap, pseudosegmented almost throughout at intervals of 30–60μ (over 40 annuli in the type 2.1 mm long), covered anteriorly for a short distance (0.45 mm in the type) with slender spines which are 13–18μ long, imbeded in cuticular folds and arranged in quincunx; posterior extremity containing refractive tissue similar to that of Säfftigen's pouch, projecting in form of a blnnt-conical or rounded knob 70–100μ in diameter. Lateral longitudinal lacunar stem more or less reticular, connecting circular vessel of each annulus. Hypodermal nuclei small, oval to elliptical, confined to lacunar vessels. Neck very short. Proboscis subcylindrical to claviform, 0.3–0.4×0.11 mm, broadest subapically, with 12 longitudinal rows of slender hooks abruptly diminishing basally; 10–11 hooks in each row; largest apical hooks 65–72μ long, smallest basal hooks 13μ long. Proboscis sheath cylindrical, 0.7–0.73×0.08–0.09 mm, double-walled, with elongate ganglion at about its middle. Lemnisci sausage-shaped, 0.35–0.4×0.07–0.08 mm, containing numerous small nuclei.

Testes elliptical, tandem, contiguous, largely pre-equatorial; anterior testis 0.34–0.38×0.11–0.12 mm, with its greater part overlapping posterior portion of proboscis sheath, posterior testis 0.26–0.3×0.11–0.15 mm, with its posterior end overlapping anterior end of cement glands. Seminal vesicle rounded, about 60μ in diameter, situated just in front of bursal cap. Cement glands cylindrical, extending closely side by side between posterior testis and bursal cap. Säfftigen's pouch claviform, 0.34–0.4×0.1–0.12 mm. Muscular cap of bursa with symmetrical, triangular, anterior recesses, and 8, digitiform, posterior rays. Genital pore ventro-subterminal, at base of above mentioned terminal knob.

Female. Trunk 2.6–3.05 mm long, gradually tapering toward ventrally curved tail end, which terminates in a small blunt-conical or rounded knob, 0.4–0.52 mm in maximum breadth near anterior end, pseudosegmented throughout as in male at intervals of 30–100μ (43 annuli in the type 3.05 mm long), covered anteriorly for a distance of 0.5–0.8 mm with slender spines which are 13–20μ long and imbedded in cuticular folds. In the type the dorsal spines extend down to the 11th annulus, while the ventral spines reach to the 13th annulus. Neck very short. Proboscis claviform, 0.4–0.5 mm×0.16–0.17 mm, with 12 longitudinal rows of 9–10 hooks each; largest apical hooks 65–78μ long, smallest basal hooks 13–18μ long. Proboscis sheath cylindrical, double-walled, 0.8×0.1–0.14 mm. Lemnisci 0.5–0.55×0.1–0.12 mm.

Uterus narrow (15μ wide) and very long; its posterior portion enclosing the vaginal funnel is very long (0.25 mm) and 31μ in maximum width in the type. There is only one sphincter 34μ in diameter; vaginal bulb pyriform, 65μ long by 44μ wide. Vulva ventrosubterminal, at base of terminal knob. Eggs elongated elliptical, three-shelled; outer shell about 56μ long by 13μ broad as mounted in balsam; middle shell with very prominent polar prolongations.

This species is characterized by the spination of the trunk like *Rhadinorhynchus* species, and moreover by a comparatively regular pseudosegmentation of the trunk wall with well developed annular lacunar system corresponding to the pseudosegmentation, to which the specific name refers. That the bursal rays are digitiform and comparatively few in number, and that the vaginal funnel is unusually long and followed by a single sphincter, together with the subterminal genital pores in both sexes are important distinguishing characters. There is no doubt that this species represents a new genus of the family Rhadinorhynchidae, for which the name *Allorhadinorhynchus* is suggested.

Allorhadinorhynchus n. g.

Generic diagnosis.—Rhadinorhynchidae. Trunk elongate, with irregular posterior swelling in male, but gradually tapered posteriorly in female, with comparatively regular pseudosegmentation throughout its length and well developed circular lacunar vessel for each annulus; hypodermal nuclei confined to lacunar vessels; anterior part of trunk covered in quincunx with slender curved spines which are imbedded in cuticulrr folds and extend on the ventral side a little further backward than on the dorsal side in the female. Proboscis claviform, with a number of longitudinal rows of slender hooks. Neck very short. Proboscis sheath cylindrical, long, double-walled, with ganglion at about its middle. Lemnisci comparatively short, containing numerous small nuclei. Testes tandem, contiguous, largely pre-equatorial; seminal vesicle rounded. Cement glands 2, cylindrical. Säfftigen's pouch elongate. Bursal rays digitiform, comparatively few in number; male genital pore subterminal, at base of terminal knob, whose pulp is similar to that of Säfftigen's pouch. Female tail curved ventrad, terminating in a small knob. Uterus long and narrow, vaginal funnel unusually long, followed by single sphincter, vaginal bulb well developed. Vulva subterminal, at base of terminal knob. Eggs three-shelled, middle shell with prominent polar prolongations.

Genotype: *A. segmentatum* n. sp.

Acknowledgments

I wish to express my gratitude to Mr. S. Ôba and Mr. T. Yamasu of the Marine Laboratory of Okayama University at Shibukawa, Tamano City, Okayama Prefecture, for their help extended to me during my stay at the Laboratory for collecting the fish parasites described here.

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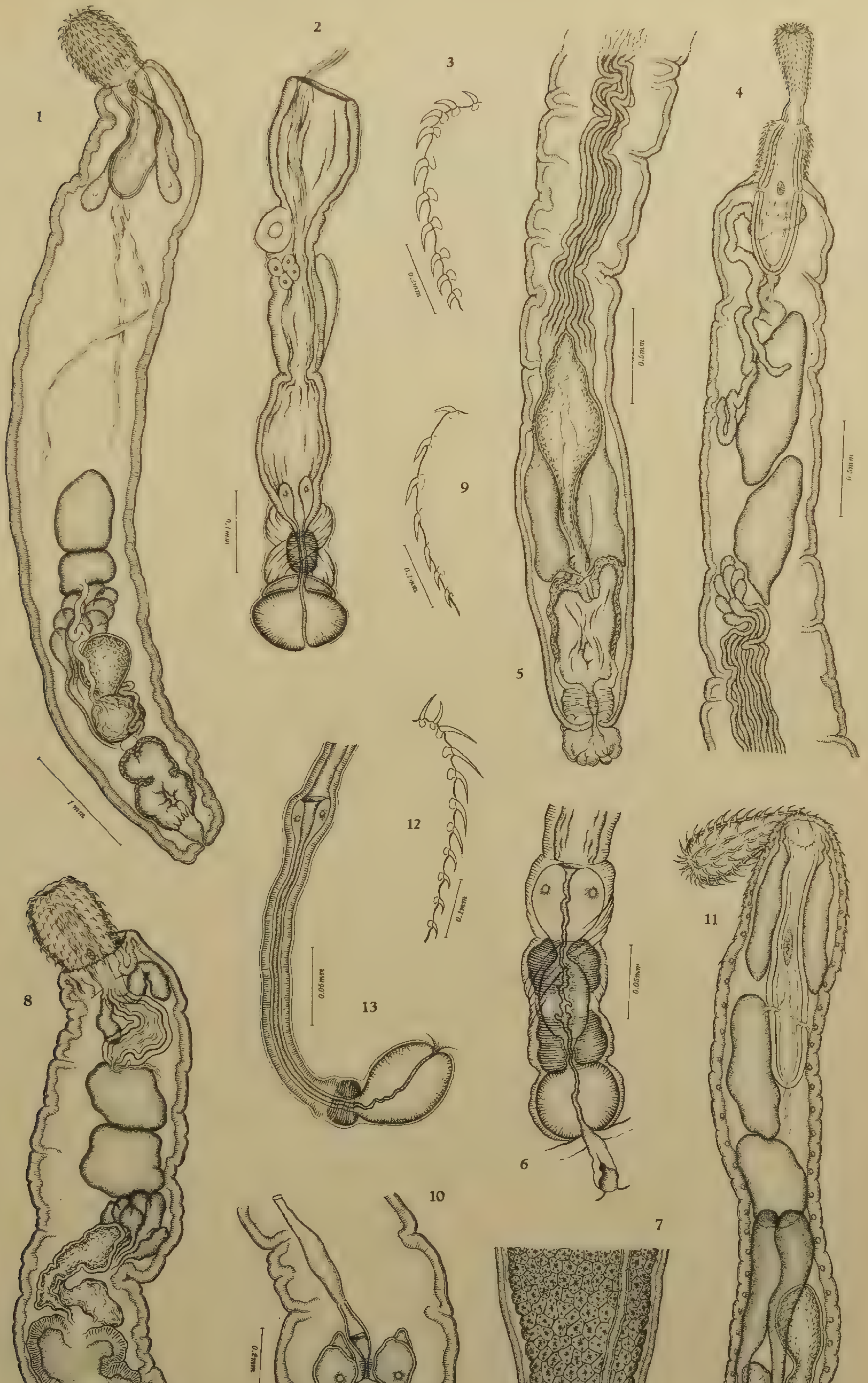
EXPLANATION OF PLATE XXVI

Figs. 1–3.	*Metacanthocephalus pleuronichthydis* n. g., n. sp.
	1, Male. 2, Female terminalia. 3, Proboscis hooks.
Figs. 4–7.	*Metarhadinorhynchus lateolabracis* n. g., n. sp.
	4, Anterior extremity of male. 5, Posterior extremity of male.
	6, Female terminalia. 7, Posterior extremity of female.
Figs. 8–10.	*Metacanthocephaloides zebrini* n. g., n. sp.
	8, Male. 9, Proboscis hooks. 10, Posterior extremity of female.
Figs. 11–13.	*Allorhadinorhynchus segmentatum* n. g., n. sp.
	11, Male. 12, Proboscis hooks. 13, Female terminalia.



S. YAMAGUTI: STUDIES ON THE HELMINTH FAUNA OF JAPAN, 55.

THE FAMILY STILIGERIDAE FROM JAPAN (OPISTHOBRANCHIA-SACOGLOSSA)[1]

KIKUTARÔ BABA

Biological Laboratory, Osaka Gakugei University

With Plates XXVII–XXVIII

The species of the sacoglossan family Stiligeridae previously recorded from our territory are enumerated below:

1. *Stiliger* (*Stiliger*) *berghi* BABA, 1937. Berugu-umiushi.
   Loc.: Osaka Bay; Inland Sea of Seto; Amakusa; Toyama Bay. Living on the red algae, *Ceramium*, *Polysiphonia* and *Galaxaura.*
2. *Stiliger* (*Stiliger*) *boodleae* BABA, 1938. Arimo-umiushi.
   Loc.: Sagami Bay; Okitsu, Suruga Bay; Sugashima near Toba; Kii; Osaka Bay; Inland Sea of Seto; Saeki Bay; Abashiri, Hokkaido; Sado I.; Nou, Niigata Pref.; Toyama Bay; Togi Kazanashi, W. coast of Noto Peninsula; Tsuruga Bay. Living on the green algae, *Boodlea*, *Enteromorpha* and *Ulva.*
3. *Stiliger* (*Ercolania*) *akkeshiensis* BABA, 1935. Ezo-tamamiru-umiushi.
   Loc.: Akkeshi Bay, Hokkaido.
4. *Stiliger* (*Ercolania*) *smaragdinus* BABA, 1949. Tamamiru-umiushi.
   Loc.: Sagami Bay; Toyama Bay. Living on the green alga, *Caulerpa.*
5. *Hermaea dendritica* (ALDER & HANCOCK, 1843). Midori-amamo-umiushi.
   Loc.: Tokyo Bay; Sagami Bay; Sugashima near Toba; Kii; Osaka Bay; Inland Sea of Seto; Amakusa; Sado I.; Toyama Bay; Hegura I., N. of Noto Peninsula. Living on the green algae, *Codium* and *Bryopsis.*
6. *Hermaeina*[2] (*Hermaeina*) *orientalis* BABA, 1949. Tôyô-moumiushi.
   Loc.: Sagami Bay; Okitsu, Suruga Bay.
7. *Hermaeina* (*Hermaeina*) *nigra* BABA, 1949. Kuro-moumiushi.
   Loc.: Sagami Bay; Toyama Bay.
8. *Alderia nigra* BABA, 1937. Matsumo-umiushi.
   Loc.: Amakusa.

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1) Contributions from the Seto Marine Biological Laboratory, No. 338.

2) *Aplysiopsis* DESHAYES, 1835–53 = *Hermaeina* TRINCHESE, 1874.
See PRUVOT-FOL, 1951, p. 69, and 1953, pp. 47–48. See also MARCUS, 1959, p. 22.

Publ. Seto Mar. Biol. Lab., VII (3), 1959. (Article 21)

The following are here added to the list above:

1. *Stiliger* (*Stiliger*) *pusillus* BABA, n. sp. Kotsubu-moumiushi (n. n.).
2. *Stiliger* (*Stiliger*) *subviridis* BABA, n. sp. Usumidori-moumiushi (n. n.).
3. *Stiliger* (*Stiliger*) *formicarius* BABA, n. sp. Oh-arimo-umiushi (n. n.).
4. *Stiliger* (*Ercolania*) *noto* BABA, n. sp. Noto-arimo-umiushi (n. n.).
5. *Stiliger* (*Ercolania*) *zosterae* BABA, n. sp. Hana-amamo-umiushi (n. n.).
6. *Hermaea cremoniana* TRINCHESE, 1893. Tsumaguro-moumiushi (n. n.).
7. *Hermaeina* (*Hermaeina*) *minor* BABA, n. sp. Hime-kuro-moumiushi (n. n.).
8. *Hermaeina* (*Hermaeina*) *toyamana* BABA, n. sp. Toyama-moumiushi (n. n.).

I am greatly indebted to Messrs. Iwao HAMATANI (Sennan Senior High School, Osaka Pref.) and Takeo ABE (Takaoka Senior High School, Toyama Pref.) for their kind help in collecting and studying animals. My cordial thanks are due to Mrs. Ruth L. KOBS, M. A., a Fulbright instructor of English in our University, for her suggestions in preparing the English manuscript.

Stiliger (*Stiliger*) *pusillus* BABA, n. sp.

(Pl. XXVII, Fig. 1; Pl. XXVIII, Fig. 1)

Highly distinctive in form, in colouring, and in radula. Total length of animal 1 mm. Rhinophores very short, stout, without an outer longitudinal groove. Foot-corners rounded. Branchial papillae always 3 on each side, the first smallest, the third largest, all inflated fusiform. General ground-colour translucent whitish, with chocolate brown spots on papillae. The anterior half of the trunk is coloured with chocolate-brown. Sole whitish. Liver-diverticula in the papillae, yellowish brown. Minute dots of opaque white everywhere on back and on under side. Radula with 3 teeth in the ascending series, and 6 in the descending series. Each tooth without an indention in the middle of the back; the ventral edge of the tooth smooth.

Loc.: Tannowa, Osaka Bay, from sandy bottom (June 1957, 3 sps., coll. by Mr. HAMATANI; July 1959, 1 sp.).

The subgenus *Stiliger* is marked by a pair of simple rhinophores. Out of a dozen or more of the previously recorded members of this subgenus, *S.* (*S.*) *talis* MARCUS, 1956, from Brazil, agrees with *pusillus* in one point that the branchial papillae are only 3 in number on each side of the body. Otherwise, the two cannot be identified with each other.

Stiliger (*Stiliger*) *subviridis* BABA, n. sp.

(Pl. XXVII, Fig. 2; Pl. XXVIII, Figs. 2a–2c)

This species resembles closely *S.* (*S.*) *varians* ELIOT, 1904, from Zanzibar, in the general body-form and also in colouring. Length of animal 5 mm. Rhinophores very long, slender, and simple (with only a trace of outer longitudinal groove near the base). Foot-corners rounded. Branchial papillae long fusiform, arranged on back-margins in about 12–13 oblique rows, at least 2 papillae in each row. Anus and nephroproct not determined. Liver-diverticula in the papillae, simple (?). Body yellowish white in ground-colour; almost everywhere it is marked by the ramification of deep green liver-diverticula shining through the transparent integument. Branchial papillae veined internally with a deep green. On the outer surface each of the papillae has a number of deep green, longitudinal lines, running towards the tip. A red marking at about the anterior end of the pericardial prominence. Sole deep green owing to the liver ramification. Radula with 3 teeth in the ascending series, 6 teeth in the descending series, and a heap of these in the ascus. Each tooth deeply indented in the middle of the back and smooth at the ventral edge. In the general shape of the radula teeth, *subviridis* does not agree exactly with *varians*.

Loc.: Abugashima, Toyama Bay, on a green alga (July 1951, 1 sp., coll. by Mr. ABE).

This is tentatively separated from *varians*, and is regarded as a new species.

Stiliger (*Stiliger*) *formicarius* BABA, n. sp.

(Pl. XXVII, Figs. 3a–3b; Pl. XXVIII, Figs. 3a–3b)

The present form comes nearest to our common species, *S.* (*S.*) *boodleae* BABA, 1938, in the general body-form and in colours, but it may easily be distinguished from the latter as follows:

S. boodleae	*S. formicarius*
1. Body small, usually 4–5 (at most 7–8) mm long.	1. Rather large, 7–10 mm.
2. Pericardial prominence ovate.	2. Exceedingly elongated behind.
3. Anus in the posterior half of the pericardial prominence.	3. At the right anterior corner of the pericardial prominence.
4. Foot-corners rounded.	4. Produced and tentaculiform.
5. Branchial papillae tipped with brown.	5. Tipped with white.

Animal rather large, 7–10 mm long, just like a black ant in appearance. Rhinophores simple (with a trace of outer longitudinal groove near the base). Foot-corners unusually produced to form long-pointed tentacles. Fusiform branchial papillae arranged in 5–7 oblique rows on back-margins, each row containing from 3 to 4 papillae. Liver-diverticula ramified in the papillae. Pericardial prominence markedly elongate-oval, extending from behind the base of the rhinophores to about the middle of the back. Anus situated at the right anterior corner of the pericardial prominence; nephroproct closely inside the anus. Genital orifice situated roughly as in *boodleae*.

General body-colour black. Almost all of the specimens have a white patch on the top of the head, between the two rhinophores. Branchial papillae always tipped with white. Sole colourless. Radula teeth 7–8 in the ascending series, and 20–25 in the descending series (Amakusa specimens); 8 in the ascending series, and about 27 in the descending series (Niigata specimen). Each tooth without an indention in the middle of the back; the ventral edge of the tooth smooth. In the shape of the radula teeth, *formicarius* differs greatly from *boodleae*.

Loc.: Tomioka, Amakusa, living on a green alga in the intertidal zone (Feb. 1940, many sps.). Nou, Niigata Pref. (July 1958, 1 sp., coll. by Mr. ABE).

Stiliger (*Ercolania*) *noto* BABA, n. sp.

(Pl. XXVII, Figs. 4a–4b; Pl. XXVIII, Figs. 4a–4b)

This species resembles closely *S.* (*S.*) *boodleae* BABA, 1938, in the black colouring of the body, but the two may be separated from each other as follows:

S. boodleae	*S. noto*
1. Rhinophores simple.	1. Auriculate.
2. Descending series of radula not spiral.	2. Spiral.
3. Radula teeth indented in the middle of the back.	3. Not indented.

Animal 5–10 mm in length. With a pair of lobiform oral tentacles. Rhinophores auriculate, having an outer longitudinal groove. Branchial papillae long fusiform. They are arranged on back-margins in 9–10 oblique rows with 1–2 papillae in each row. Liver-diverticula ramified in the papillae, but no branching of the albumen gland in these structures. Pericardial prominence ovate; anus and nephroproct not determined. General aspect of the animal black. Head especially marked by having 4 longitudinal bands of intense black; the median part of the head and the eye-regions white. Back black. It is somewhat deeper towards the outer edges of the mantle and in the median line behind the pericardial prominence. Upper half of the oral tentacles and of the rhinophores opaque white. The pericardial region also opaque white. The branchial papillae black, the inner and the outer edges towards the end opaque white, their tips yellowish brown; the inner veins of the papillae dark yellow. Sole yellowish white. Radula teeth 10 in the ascending series, and about 38 in the descending spiral series. Each tooth without an indention in the back; the ventral edge smooth (?).

Loc.: Usetsu, Toyama Bay (July 1953, 2 sps., coll. by Mr. ABE). Hegura I., N. of Noto Peninsula (Aug. 1957, 2 sps., coll. by Mr. ABE). Togi Kazanashi, W. coast of Noto Peninsula (Aug. 1957, 2 sps., coll. by Mr. ABE).

The subgenus *Ercolania* differs from *Stiliger* s. s. in the auriculate rhinophores. About 8 species of *Ercolania* have hitherto been recorded from the world, none of which coincides with our species, *noto*, in colours.

Stiliger (*Ercolania*) *zosterae* BABA, n. sp.

(Pl. XXVII, Fig. 5; Pl. XXVIII, Figs. 5a–5b)

Very small, about 3 mm in length. Rhinophores auriculate. Branchial papillae short fusiform, arranged in a single row of 6–7 on each side, very irregular in size. Foot-corners rounded. General ground-colour of the animal whitish. Head above marked with a purple-red U-letter, the legs running up into the lower halves of the rhinophores. There is an additional purple-red band on each side of the neck; it is divided into two interrupted stripes which pass down the body to near the tip of the tail. Branchial papillae veined with light olive-green, their tips chrome-yellow, their surface ornamented with 3 longitudinal stripes of purple-red. Rhinophores tipped with opaque white. Radula teeth 6 in the ascending series, and about 13 in the descending series. Each tooth straight on the back, and smooth on the ventral edge.

Loc.: Tomioka, Amakusa, living on *Zostera marina* (Dec. 1936, 1 sp.).

This species is unmistakable in colours in the subgenus *Ercolania.*

Hermaea cremoniana TRINCHESE, 1893

(Pl. XXVII, Figs. 6a–6b; Pl. XXVIII, Figs. 6a–6d)

Hermaea cremoniana TRINCHESE, 1893, pp. 154-155.—Naples; TRINCHESE, 1896, pp. 35–45, 2 pls.

Total length of animal 5–15 mm. Rhinophores auriculate. Branchial papillae fusiform and very long; they are arranged on back-margins in 15–20 oblique rows, with 4–5 papillae in each row. Within each of these papillae there appears a simple liver-diverticulum, which, in turn, is often accompanied by convoluted canals of the albumen gland (see the characterization of the genus *Hermaea* by MACNAE, 1954, p. 59). Pericardial prominence elongate-oval; anus and nephroproct not determined. Foot-corners rounded. Colouring distinctive and quite unmistakable. The whole animal including the sole, deep orange-yellow in ground-colour. Head and rhinophores black; eye-regions white; median part of back and sides of body, black; branchial papillae orange-yellow below, black above. Radula teeth 11 in the ascending series, and about 18 in the descending series; all of them smooth on the ventral edge.

Loc.: Seto, Kii, in tide pools (Sept. 1957, 4 sps., coll. by Mr. HAMATANI). Abugashima, Toyama Bay (Aug. 1954, 4 sps., coll. by Mr. ABE). Hegura I., N. of Noto Peninsula (Aug. 1957, 1 sp., coll. by Mr. ABE).

At present, a little more than 10 species are known of the genus *Hermaea.* Our specimens are here referred to *cremoniana* from Naples mainly by colours and by the type of the radula.

Hermaeina (*Hermaeina*) *minor* Baba, n. sp.

(Pl. XXVII, Fig. 7; Pl. XXVIII, Figs. 7a–7c)

Animal black-coloured as in *H.* (*H.*) *nigra* Baba, 1949. Total length 7–10 mm. Rhinophores auriculate. Oral tentacles lobiform. Branchial papillae rounded in section, smooth on the surface, having no dendritic veins as seen in *nigra*; they are arranged on back-margins in 7 oblique rows, with about 2 papillae in each row. Liver-diverticula branching within the papillae (?). Anus closely in front of the ovate pericardial prominence, within which opens a nephroproct. Foot-corners rounded. Body black above; the branchial papillae also black to the tip; the sole yellowish white with two longitudinal black bands. A white patch around the eye on each side; it runs up to the tip of the rhinophore. Radula as formal in the genus *Hermaeina*: about 6 teeth in the ascending series, and 32 teeth in the descending spiral series; each tooth with a deep indention in the middle of the back; the ventral edge of the tooth finely denticulated.

Loc.: Amaharashi, Toyama Bay (Jan. and May 1957, 7 sps., coll. by Mr. Abe).

The genus *Hermaeina* differs from *Hermaea* in that the descending series of the radula is coiled spirally. Each tooth has an indention on the back, and a series of denticulations on the ventral edge. The branching of the albumen gland does not pass into the branchial papillae. Six species of *Hermaeina* have hitherto been recorded. The new species, *minor*, appears to be closely allied to *nigra* in the black colouring, but it is separated from the latter as follows:

H. nigra	*H. minor*
1. Body up to 30 mm long.	1. Smaller, 7–10 mm.
2. Branchial papillae rather thickly-set, in about 25 oblique rows.	2. Not so thickly-set, only in about 7 oblique rows.
3. Branchial papillae with weak branching veins on the inner surface.	3. Smooth, no veins on surface.
4. Sole uniformly dark.	4. With two longitudinal black bands.

Hermaeina (*Hermaeina*) *toyamana* Baba, n. sp.

(Pl. XXVII, Figs. 8a–8d; Pl. XXVIII, Figs. 8a–8c)

This is closely allied to *H.* (*H.*) *orientalis* Baba, 1949 in the general aspect. Animal 7 mm long, rhinophores auriculate, oral tentacles lobiform, foot-corners rounded. Branchial papillae arranged on back-margins in about 13 oblique rows, 2–3 papillae in each row. The ridge-like veins on the inner surface of the papillae weak and not so thickly branching as in *orientalis*. Body yellowish white in ground-colour. A median black band on head (not a brown band as in *orientalis*); it passes in front along the anterior margin of the rhinophores. Posteriorly the band becomes rather ill-defined, but still it extends down the back. Branchial papillae grass-green with black tips. On the outer surface each of the papillae is often marked by a pair of brown bands which run down obliquely from the tip. An additional opaque-white line medianly on the outer surface; the branching veins on the inner surface of the papillae opaque white. Rhinophores with a longitudinal opaque white line. Sole yellowish white, and with two longitudinal black bands (not brown bands as in *orientalis*). The type of the radula approximately as in *orientalis*: about 7 teeth in the ascending series, and 35 teeth in the descending spiral series; each tooth with an indention on the back and a series of denticles on the ventral edge.

Loc.: Abugashima, Toyama Bay, on a green alga (July 1952, 1 sp., coll. by Mr. ABE). Amaharashi, Toyama Bay (June and July 1958, 7 sps., coll. by Mr. ABE). Mera, Fukui Pref., on a green alga, *Cladophora* (July 1959, 2 sps., coll. by Mr. ABE).

The present form is tentatively separated from *orientalis* by the weak veins on the inner surface of the papillae, and by the detail of the body-colours.

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EXPLANATION OF PLATES XXVII–XXVIII

PLATE XXVII

Fig. 1. *Stiliger (Stiliger) pusillus* (Tannowa, Osaka Bay, June 30, 1957, length 1 mm).

Fig. 2. *Stiliger (Stiliger) subviridis* (Abugashima, Toyama Bay, July 24, 1951, length 5 mm).

Figs. 3a–3b. *Stiliger (Stiliger) formicarius* (Tomioka, Amakusa, Feb. 24, 1940, length 10 mm). 3a. Animal; 3b. A branchial papilla.

Figs. 4a–4b. *Stiliger (Ercolania) noto* (Togi Kazanashi, W. coast of Noto Peninsula, Aug. 4, 1957, length 5 mm). 4a. Animal; 4b. A branchial papilla.

Fig. 5. *Stiliger (Ercolania) zosterae* (Tomioka, Amakusa, Dec. 20, 1936, length 3 mm).

Figs. 6a–6b. *Hermaea cremoniana* (Seto, Kii, Sept. 22, 1957, length 5 mm). 6a. Animal; 6b. A branchial papilla; the liver-diverticulum is seen accompanied by convoluted canals of the albumen gland.

Fig. 7. *Hermaeina (Hermaeina) minor* (Amaharashi, Toyama Bay, Jan. 26, 1957, length 10 mm, original fig. by Mr. ABE).

Figs. 8a–8d. *Hermaeina (Hermaeina) toyamana* (Abugashima, Toyama Bay, July 21, 1952, length 7 mm). 8a. Animal; 8b. A branchial papilla on the inner surface; 8c. The same on the outer surface; 8d. The same with a branching liver-diverticulum.

PLATE XXVIII

Fig. 1. *Stiliger (Stiliger) pusillus.*
Radula teeth (×650).

Figs. 2a–2c. *Stiliger (Stiliger) subviridis.*
2a. Under side of head and foot; 2b. Radula teeth (×20); 2c. A tooth (×200).

Figs. 3a–3b. *Stiliger (Stiliger) formicarius.*
3a. Radula teeth (×170); 3b. A tooth (×330).

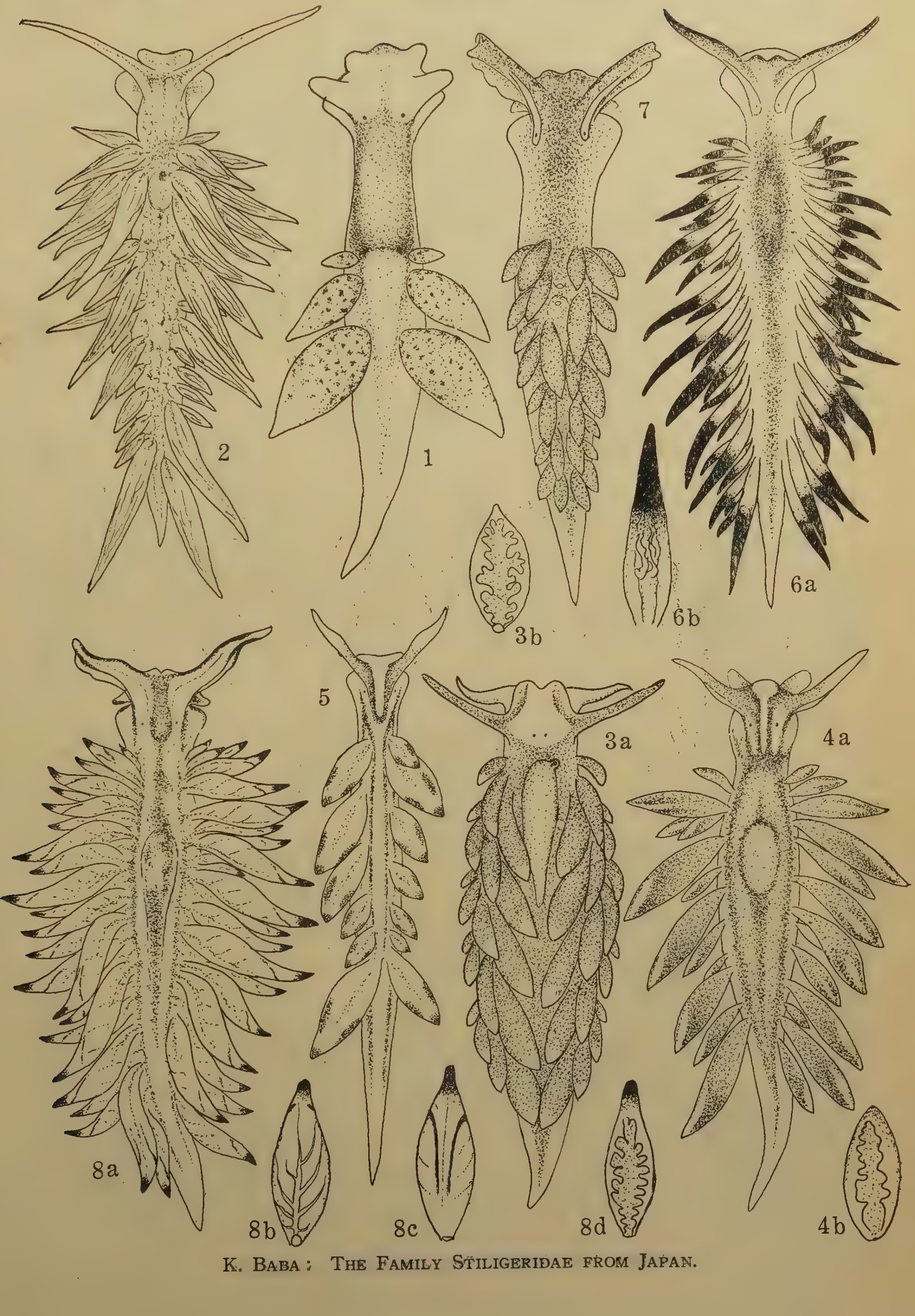
Figs. 4a–4b. *Stiliger (Ercolania) noto.*
4a. Radula teeth (×190); 4b. A tooth (×350).

Figs. 5a–5b. *Stiliger (Ercolania) zosterae.*
5a. Radula teeth (×300); 5b. A tooth (×520).

Figs. 6a–6d. *Hermaea cremoniana.*
6a. Right side of animal; 6b. Under side of head and foot; 6c. Radula teeth (×260); 6d. A tooth (×450).

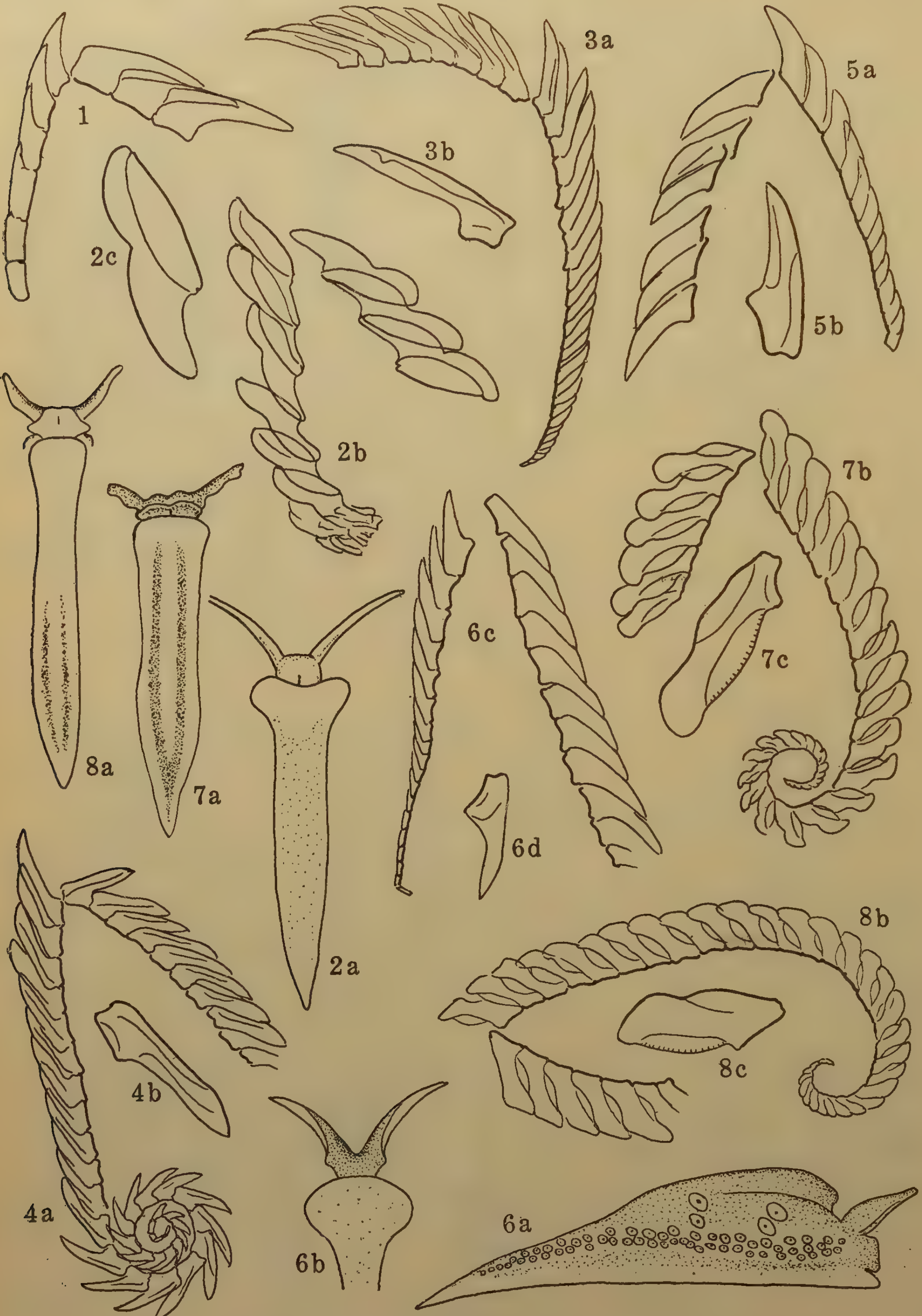
Figs. 7a–7c. *Hermaeina (Hermaeina) minor.*
7a. Under side of head and foot; 7b. Radula teeth (×90); 7c. A tooth (×170).

Figs. 8a–8c. *Hermaeina (Hermaeina) toyamana.*
8a. Under side of head and foot; 8b. Radula teeth (×90); 8c. A tooth (×150).



K. BABA: THE FAMILY STILIGERIDAE FROM JAPAN.

PLATE XXVIII



K. BABA: THE FAMILY STILIGERIDAE FROM JAPAN.

A NEW RECORD OF AN INTERESTING SPECIES, *EMBLETONIA GRACILE* RISBEC, FROM JAPAN (NUDIBRANCHIA-EOLIDACEA)

Kikutarô BABA

Biological Laboratory, Osaka Gakugei University

With Plate XXIX

Embletonia is a small genus of the family Tergipedidae, and about four species have hitherto been recorded from various waters of the world (see also Marcus, 1957, p. 467): *E. pulchra* (Alder & Hancock, 1844); *E. faurei* Labbé, 1923; *E. gracile* Risbec, 1928; *E. evelinae* Marcus, 1957. The specimens in hand are recognized as identical with *E. gracile* Risbec, and they appear to be especially marked by the branchial papillae, each of which is divided into four twigs at the top. My thanks are due to Dr. Hirotaro Hattori, Chief of the Biological Laboratory of the Imperial Household, Tokyo, and to Mr. Iwao Hamatani of the Sennan Senior High School, Osaka, for placing their valuable collections at my disposal for examination. The English manuscript has kindly been revised by Mrs. Ruth L. Kobs, M. A., a Fulbright instructor of English in our University.

Embletonia gracile Risbec, 1928

Yotsumata-minoumiushi (n. n.)

(Pl. XXIX, Figs. A–I)

Embletonia gracile Risbec, 1928, pp. 271–272, fig. 91, pl. 12, fig. 11.—N. Caledonia; Risbec, 1953, p. 139, figs. 94, 96 b.—N. Caledonia.

Body small, linear, about 8 mm in total length. Head expanded antero-laterally to form a pair of thin lobes, but there are no oral tentacles. Rhinophores clavate, simple. Foot-corners rounded. Gills in a single row of 7–8 papillae on each side; the foremost two papillae on the right and on the left belong to the right liver and the left partner respectively; the rest of the papillae are in combination with the posterior liver; genital orifice between and below the first and the second papillae on the right side; acleioproctic anus closely in front of the third papilla on the same side. The branchial papillae are each marked by having four apical twigs. The

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liver-diverticulum within the papillae simple, not forming a cnidosac. Body slightly yellowish white, with yellow liver-veins which shine through the integument. Jaw-edge (?). Radula formula 72×0.1.0; each tooth horseshoe-shaped as usual, and with 3–4 denticles on each side of the median cusp.

Loc.: Ogashima, Sagami Bay, in shallow water (Aug. 1949, 1 sp., coll. by the Biological Laboratory, Imperial Household).

Two more specimens were obtained by Mr. HAMATANI from Tannowa, Osaka Bay, in March 1959. Length of animal 3–4 mm. The branchial papillae number 4–5 on each side. They are fusiform and short in contraction, but they may extend greatly; at the top they are divided into four twigs as shown in the Sagami specimen. General body-colour slightly yellowish white, with vivid orange-yellow liver-diverticula entering into the branchial papillae. An opaque white marking on the head in the centre. Minute dots of opaque white sprinkled everywhere on the back and on the papillae. Jaw-edge (?). Radula formula 80×0.1.0; each tooth with a median cusp and 3–4 flanking denticles.

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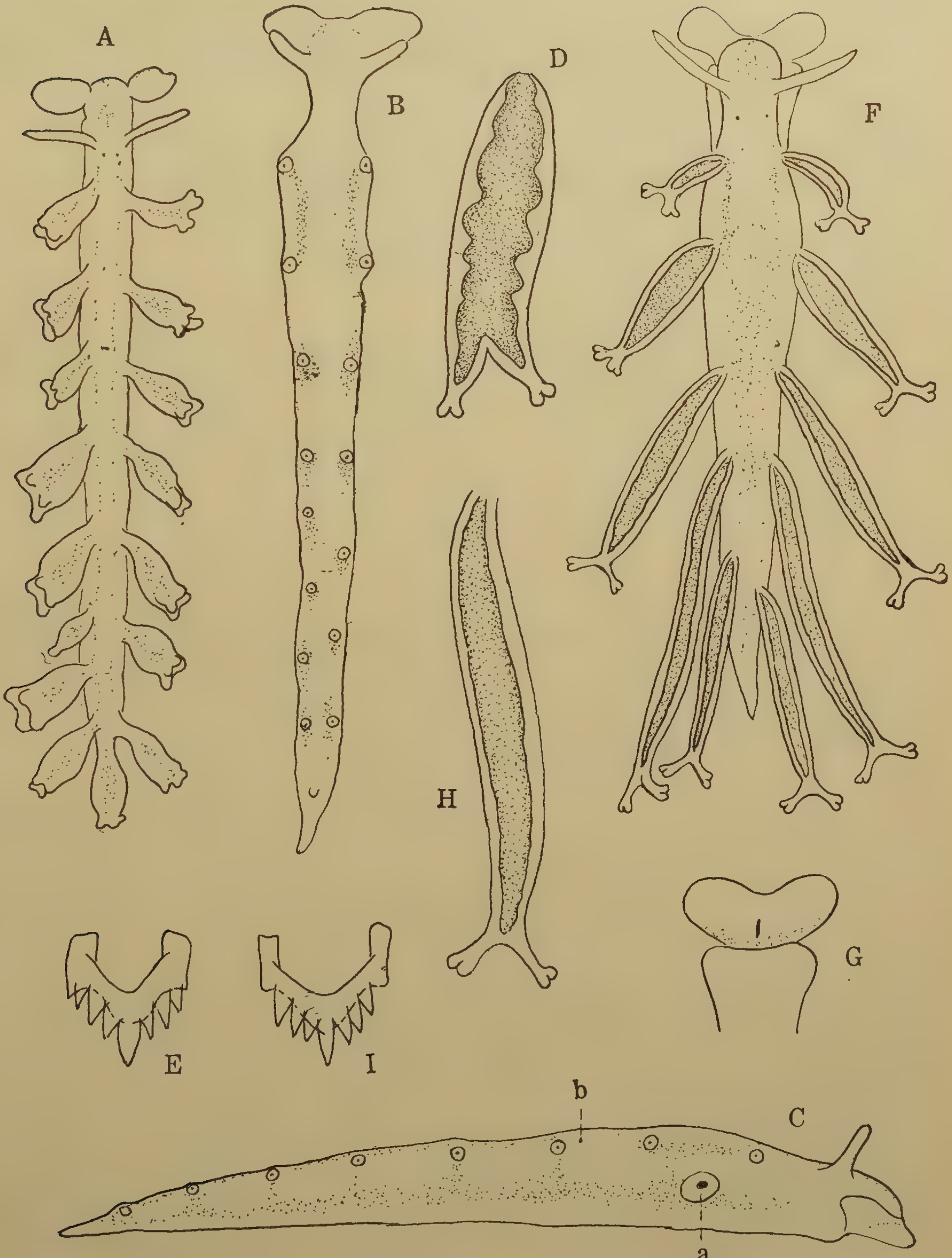
EXPLANATION OF PLATE XXIX

Figs. A–E. *Embletonia gracile* from Sagami Bay (Aug. 22, 1949).
Fig. A. A living animal (length 8 mm, original fig. by the Biological Laboratory, Imperial Household).
Fig. B. Organization from above.
Fig. C. Organization from right side; a. genital orifice, b. anus.
Fig. D. A contracted branchial papilla in preservation.
Fig. E. A radula tooth (×720).
Figs. F–I. *Embletonia gracile* from Osaka Bay (Mar. 28, 1959).
Fig. F. A living animal (length 3–4 mm).
Fig. G. Head and foot from below.
Fig. H. A fully extended branchial papilla in fresh.
Fig. I. A radula tooth (×800).



K. Baba : New Record of *Embletonia gracile* Risbec from Japan.

THE GENUS *PETALIFERA* AND A NEW SPECIES, *P. RAMOSA*, FROM JAPAN

Kikutarô BABA
Biological Laboratory, Osaka Gakugei University

With 1 Text-figure

It appears certain to me that the genus *Petalifera* consists of three definite species as below (cf. Engel, 1936, pp. 54–55):

1. *Petalifera petalifera* (Rang, 1828).
   Shell broad, quadrangular.
   Dist.: Atlantic; Mediterranean.
2. *Petalifera albomaculata* (Farran, 1905).
   Shell broad, mytiliform.
   Dist.: Indian Ocean.
3. *Petalifera punctulata* (Tapparone-Canefri, 1874). Uminamekuji.
   Shell narrow, spatuliform.
   Dist.: Japan; Chefoo; Jibuti (?).
   Loc.: Sagami Bay; Toba; Kii; Osaka Bay; Inland Sea of Seto; Amakusa; Asamushi; Nou, Niigata Pref.; Toyama Bay.

The following one is added to the above list.

Petalifera ramosa Baba, n. sp.

Fusa-uminamekuji (n. n.)

This is a well-marked and distinct species. (1) The animals are large, 5–7 cm long, and somewhat plump in appearance. (2) They have an unusually thick papillation on the back. Many of the papillae are small and conical, and in places come together to form compound tubercles. The largest of the papillae are branched many times, and stand out among the smaller ones. (3) The common genital orifice opens within the dorsal slit. (4) The shell is broad and circular in front, and protrudes in a rostrum behind. Coloration of the body roughly as in *P. punctulata*; grass-green to dark brown in different individuals. Sole with pale roundish markings on the green ground. Jaw-plates semicircular, formed of simple elements. Radula

Publ. Seto Mar. Biol. Lab., VII (3), 1959. (Article 23)

formula 30–32×35–40.1.35–40. Central tooth shaped as usual; lateral teeth denticulated on both edges (denticles on inner edge, 2–4, and on outer edge, 3–5).

Loc.: Tomioka, Amakusa, in *Zostera* zone (Oct. 1933, 1 sp.; Sept. 1938, 1. sp.; Jan. 1939, 5 sps.). Misaki, Sagami Bay, in *Zostera* zone (Nov. 1953, 1 sp., coll. by Mr. M. Horikoshi).

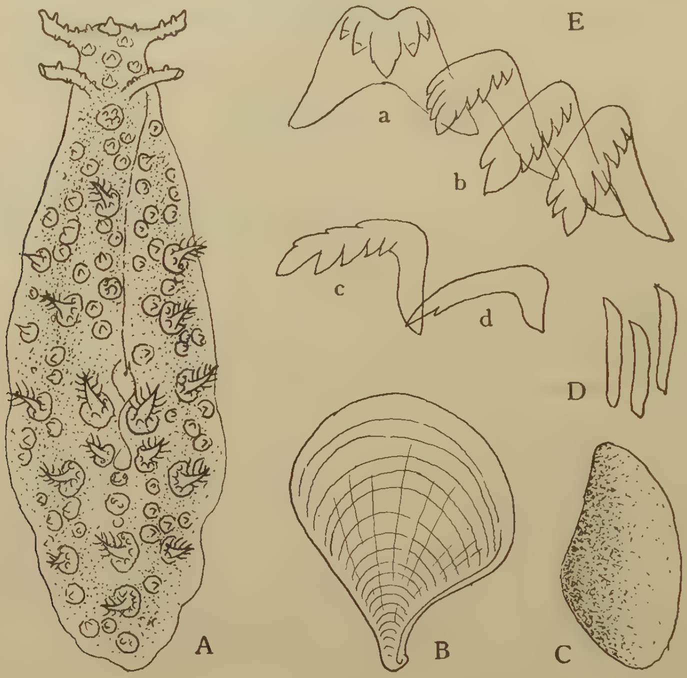


Fig. 1. *Petalifera ramosa.*
A. Entire animal (Amakusa, Jan. 15, 1939, length 5–7 cm); B. Shell (×4); C. A jaw-plate (×20); D. Elements of jaw-plate (×240); E. A half-row of radula (×240), a. central tooth, b. innermost laterals, c. 20th lateral, d. outermost lateral.

The following is a concise table to distinguish the two species of *Petalifera* occurring in the seas around us.

P. punctulata	*P. ramosa*
1. Small, 2–4 cm long.	1. Large, 5–7 cm long.
2. Dorsal papillation not thick.	2. Very thick.
3. Genital orifice in front of the dorsal slit.	3. Within the dorsal slit.
4. Shell narrow, spatuliform.	4. Broad, circular in front.

REFERENCE

Engel, H. 1936. Ueber westindische Aplysiidae und verwandten anderer Gebiete. Capita Zoologica, vol. 8, pt. 1.

STUDIES ON THE PIGMENTS OF MARINE ANIMALS

VII. CAROTENOIDS IN THE SKIN AND FINS OF SOME MARINE FISHES

KOKICHI NISHIBORI

Notre Dame Seishin College, Okayama

With Plate XXX, 5 Table and 5 Text-figures

The skin and fins of fishes show various colours which are mainly due to melanins and carotenoids. The carotenoids of the skin and fins of fish have been investigated by many workers and the results were summarized by FOX (1953), GOODWIN (1952) and KARRER (1950). They pointed out that xanthophyll, astaxanthin and taraxanthin are predominant but the isolation of the crystalline carotenoid has not been achieved in the majority of cases.

The present study concerns carotenoids in the skin and fins of four species of

Table 1. Species, numbers and colours of the marine fishes analysed.

Species	No. of specimens for sample	Colour of skin and fine
Parabembras curtus	14	Red
Lepidotrigla microptera	10	Orange-red
Sebastes inermis	6	Dirty brown-red
Taius tumifrons	3	Yellow-pink

Table 2. Absorption maxima of carotenoids in the skin and fins of four species of marine fish (in CS_2).

Species	Free xanthophyll	Esterified xanthophyll		Carotenoid hydrocarbon
		Astacene	Yellow xanthophyll	
Parabembras curtus	**—	~510 mμ	f(II) 438, 466, 498 mμ	**—
Lepidotrigla microptera	**—	~510 mμ	f(I) 438, 465, 497 mμ	**—
Sebastes inermis	**—	~510 mμ	f(I) 438, 467, 500 mμ	*f(I) 440, 468, 500 mμ f(II) 443, 472, 498 mμ
Taius tumifrons	**—	~510 mμ	f(I) 473, 500 mμ *f(III) 439, 466, 498 mμ	f(I) 438, 466, 498 mμ

* The main zone of chromatographic adsorption.
** The amount was too minute to determine.

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marine fish having a red, brown-red and yellow-pink colour (Table 1). The results are summarized in Table 2.

The principal carotenoid of each species is found in the fraction of esterified xanthophyll, which is divided into two fractions; one of which is red and the other is yellow. The former seems to be esterified astaxanthin, as the crystalline red ketonic carotenoid which is recognized to be identical with astacene because of its properties (crystalline form, melting point, absorption maximum alone and when mixed with authentic astacene prepared from lobster) has been isolated. The latter is a yellow xanthophyll having absorption maxima at 438, 466, 498 mμ (in CS_2) which resembles sarcinaxanthin.

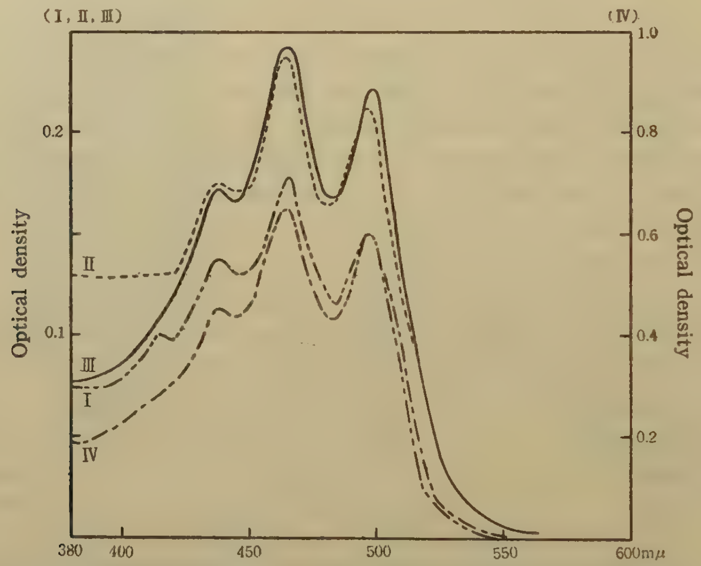


Fig. 1. Absorption spectra of the principal yellow xanthophyll separated from the skin and fins of four species of marine fish, in carbon disulphide.

I) *Parabembras curtus.* II) *Lepidotrigla microptera.*
III) *Sebastes inermis.* IV) *Taius tumifrons.*

Carotenoid	Absorption maxima in CS_2
Yellow xanthophyll from the skin and fins of marine fish	438, 466, 498 mμ
Sarcinaxanthin	436, 466.5, 499 mμ
Taraxanthin	441, 469, 501 mμ

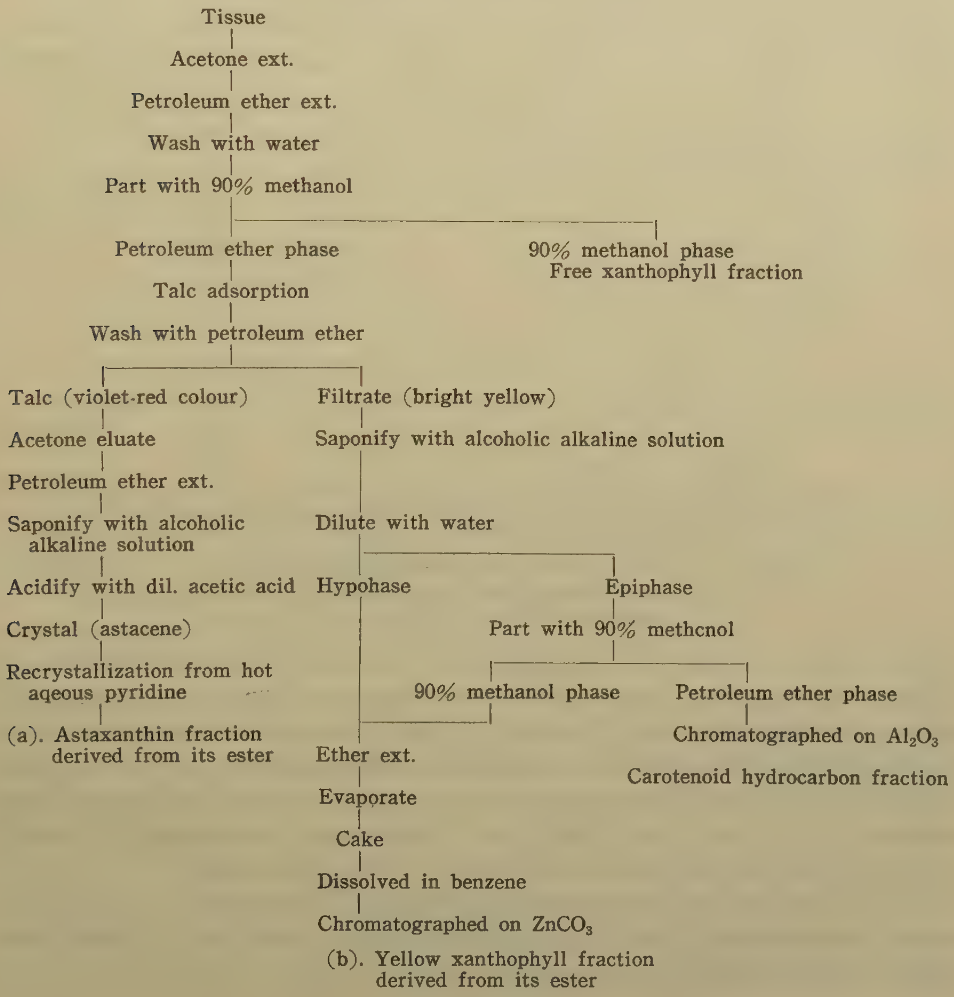
This yellow xanthophyll is contained in each of the four species and forms a main yellow pigment component (Fig. 1).

The colour of the skin and fins of fishes examined, is affected mainly by the concentration of astaxanthin and the yellow xanthophyll ; in the case of *Parabembras curtus* having red skin and fins, the concentration of astaxanthin is much greater than that of the yellow xanthophyll, and in the case of *Taius tumifrons* having yellow-pink skin and fins, however, the concentration of astaxanthin and yellow xanthophyll is not so different. (see Tables 4, 5 and Fig. 5)

Material and method

The specimens of the marine fishes used in this experiment are shown in Table 1. Extraction and separation of the carotenoid was carried out in the procedure shown in Table 3.

Table 3. Extraction and separation method


Tissue
Acetone ext.
Petroleum ether ext.
Wash with water
Part with 90% methanol
Petroleum ether phase
90% methanol phase
Free xanthophyll fraction
Talc adsorption
Wash with petroleum ether
Talc (violet-red colour)
Filtrate (bright yellow)
Acetone eluate
Saponify with alcoholic alkaline solution
Petroleum ether ext.
Saponify with alcoholic alkaline solution
Dilute with water
Acidify with dil. acetic acid
Hypohase
Epiphase
Crystal (astacene)
Part with 90% methcnol
Recrystallization from hot aqeous pyridine
90% methanol phase
Petroleum ether phase
(a). Astaxanthin fraction derived from its ester
Chromatographed on Al_2O_3
Ether ext.
Carotenoid hydrocarbon fraction
Evaporate
Cake
Dissolved in benzene
Chromatographed on $ZnCO_3$
(b). Yellow xanthophyll fraction derived from its ester

Result

The principal pigment was found in the fraction of esterified xanthophyll. Detailed results for each of marine fishes are given below.

I. *Parabembras curtus* (TEMMINCK et SCHLEGEL) (Japanese name; Ubagochi).

An amount of 60 g of skin and fins from 14 freezing specimens obtained at a fish-market was used for acetone extraction. The freshness of the samples was not so good.

Free xanthophyll fraction: None of carotenoid was detected.

Esterified xanthophyll fraction: (a) Astaxanthin fraction. Crystalline carotenoid, violet-black needle, was isolated (Plate XXX, fig. 1). It melts at 214°C and showed the absorption maximum at ~510 mμ in carbon disulphide (Fig. 2, I). CARR-PRICE reaction (+) blue, conc. H_2SO_4 reaction (+) blue. Mixed absorption maximum with astacene (isolated from a deep-water lobster, *Linuparus trigonus* VON SIEBOLD, m. p. 217°C, Plate XXX, fig. 2, absorption maximum ~510 mμ in CS_2, Fig. 3, II) was at ~510 mμ in the same solvent. (Fig. 2, II). These properties indicate that the crystalline carotenoid is identical with astacene.

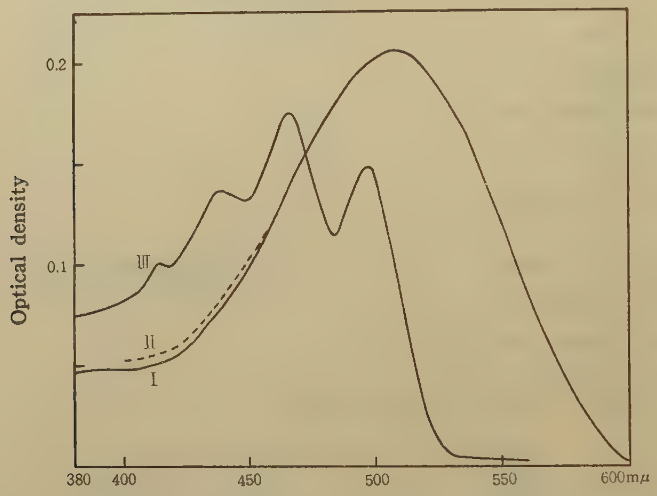


Fig. 2. Absorption spectra of carotenoids from the skin and fins of *Parabembras curtus*, in carbon disulphide.

I) Astacene from the esterified astaxanthin.
II) Mixed solution of I and lobster astacene.
III) Yellow xanthophyll zone (ii).

(b) Yellow xanthophyll fraction. Two zones were formed when it was chromatographed on the column of zinc carbonate from benzene solution and developed with petroleum ether containing acetone (10%).

Colour of zone	Absorption maxima in CS_2
(i) Red-pink	———
(ii) Deep yellow (main zone)	413, 438, 466, 498 mμ

The absorption spectrum of (ii) was shown in Fig. 2, III.

Carotenoid hydrocarbon fraction: The colour of this fraction was too minute to determine.

II. *Lepidotrigla microptera* (GÜNTHER) (Japanese name; Kanagashira).

An amount of 70 g of skin and fins from 10 freezing specimens obtained at a fish-market was used.

Free xanthophyll fraction: The 90% methanol solution of this fraction was almost entirely colourless.

Esterified xanthophyll fraction: (a) Astaxanthin fraction. Black-violet needles, m. p. 214°C (Plate XXX, fig. 3) were isolated. Absorption maximum was at ∼510 mμ in carbon disulphide. Mixed absorption maximum with astacene was at ∼510 mμ in carbon disulphide. CARR-PRICE reaction (+) blue.

(b) Yellow xanthophyll fraction. Two zones were formed from the top of the column of zinc carbonate when it was developed with petroleum ether containing acetone (10%).

Colour of zone	Absorption maxima in CS_2
(i) Light pink	
(ii) Yellow (main zone)	438, 465, 497 mμ

The absorption spectrum of (ii) was shown in Fig. 1, II.

Carotenoid hydrocarbon fraction: The amount of the carotenoid in this fraction was little.

III. *Sebastes inermis* (CUVIER et VALENCIENNES) (Japanese name; Mebaru).

An amount of 60 g of the fresh skin and fins from 6 specimens (about 15 cm in average length) collected at Okayama Prefecture was used for extraction.

Free xanthophyll fraction: The 90% methanol solution containing the pigment of this fraction was almost colourless.

Esterified xanthophyll fraction: (a) Astaxanthin fraction. Black-violet sickle-shaped needles, m. p. 221.5°C, were isolated (Plate XXX, fig. 4). The yield was about 1 mg. Absorption maximum was at ∼510 mμ in carbon disulphide (Fig. 3, I). It possessed a hypophasic property and was soluble in organic solvents (chloroform, carbon disulphide, pyridine and acetone) and sparingly soluble in petroleum ether. CARR-PRICE reaction (+) violet, conc. H_2SO_4 reaction (+) blue, mixed absorption maximum with astacene showed also at ∼510 mμ in carbon disulphide (Fig. 3, III).

(b) Yellow xanthophyll fraction. The bulk of the yellow pigment was found in this fraction. Bright yellow benzene solution was chromatographed on the column of zinc carbonate and developed with petroleum ether containing acetone (10%).

Deep red zone (i), moving down slowly, was found. The absorption maxima of (i) showed at 438, 467, 500 mμ in carbon disulphide (Fig. 3, IV). Any attempt to isolate the crystalline carotenoid failed.

Carotenoid hydrocarbon fraction: This faction was poor in colour. The petroleum ether solution (light yellow) was chromatographed on the column of alumina (Merck) and developed with petroleum ether containing acetone (10%).
Three zones were formed.

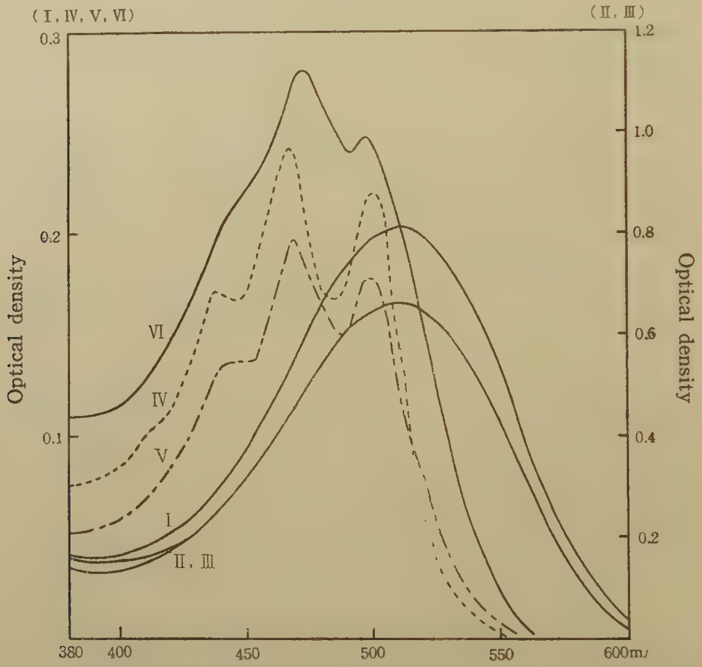


Fig. 3. Absorption spectra of carotenoids from the skin and fins of *Sebastes inermis*, in carbon disulphide.

I) Astacene from the esterified astaxanthin fraction.
II) Astacene from lobster.
III) Mixed solution of I and II.
IV) Yellow xanthophyll, zone (i).
V) Carotenoid hydrocarbon zone (i).
VI) Carotenoid hydrocarbon zone (ii).

	Colour of zone	Absorption maxima in CS_2
(i)	Bright yellow (main zone)	~440, 468, 500 mμ
(ii)	Light orange	~443, 472, 498 mμ
(iii)	Extremely light yellow	——

The absorption spectra of (i) and (ii) were shown in Fig. 3, V and VI.

IV. *Taius tumifrons* (TEMMINCK et SCHLEGEL) (Japanese name ; Kidai).

An amount of 60 g of skin and fins from 3 specimens (20 cm in average length) collected at Okayama Prefecture were used.

Free xanthophyll fraction : Trace of colour was detected.

Esterified xanthophyll fraction : (a) Astaxanthin fraction. Crystalline carotenoid, m. p. 205°C, black-violet sickle-shaped needle, was isolated (Plate XXX, fig. 5). The absorption maximum was at ~510 mμ in carbon disulphide (Fig. 4, I). It had hypophasic property. CARR-PRICE reaction (+) blue, conc. H_2SO_4 reaction (+) blue. There was no displacement of the absorption maximum mixed with the lobster astacene (Fig. 4, II).

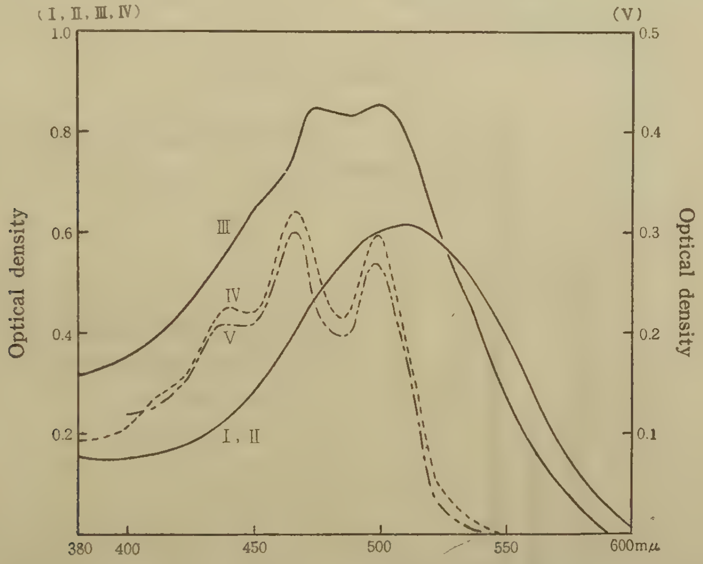


Fig. 4. Absorption spectra of carotenoids from the skin and fins of *Taius tumifrons*, in carbon disulphide.

I) Astacene from the esterified astaxanthin.
II) Maxed solution of I and lobster astacene.
III) Yellow xanthophyll zone (i).
IV) Yellow xanthophyll zone (iii).
V) Carotenoid hydrocarbon zone(i).

(b) Yellow xanthophyll fraction. The yellow colour of the specimens owed to this fraction. When the benzene solution of the pigment was chromatographed on the column of zinc carbonate and developed with petroleum ether containing acetone (10%), three zones were obtained from the top of the column.

	Colour of zone	Absorption maxima in CS_2
(i)	Bright red	473, 500 mμ
(ii)	Extremely light yellow	-
(iii)	Orange (main zone)	439, 466, 498 mμ

The absorption spectra of (i) and (iii) was shown in Fig. 4, III and IV.

Carotenoid hydrocarbon fraction: Two zones were found when the petroleum ether solution (light yellow) of this fraction was chromatographed on the column of alumina and developed with petroleum ether containing acetone (10%).

	Colour of zone	Absorption maxima in CS_2
(i)	Yellow (main zone)	438, 466, 498 mμ
(ii)	Extremely light yellow	————

The absorption spectrum of (i) was shown in Fig. 4, V.

V. Determination of concentration of the red and yellow carotenoid.

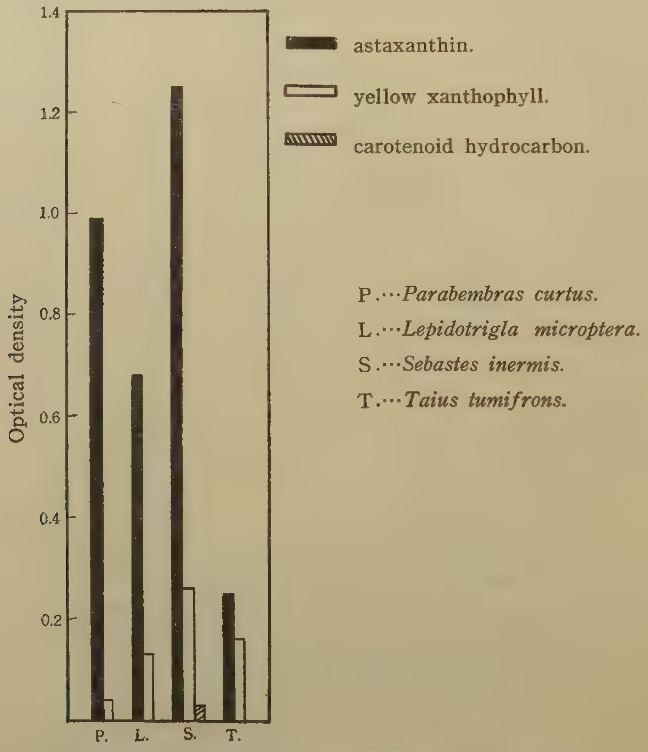


Fig. 5. Relative concentration of astaxanthin, yellow xanthophyll and carotenoid hydrocarbon in the skin and fins of four species of marine fish.

Carotenoid pigments in the 17 g of the skin and fins of each of four species of marine fish, were extracted entirely and separated into three fractions; astaxanthin (red colour), yellow xanthophyll (yellow colour) and carotenoid hydrocarbon (yellow colour). Each fraction was dissolved in 200 cc of carbon disulphide respectivelly and determined their own optical density (AKA type electric colorimeter. Cell; 1 cm, Filter ; S_{50} for astaxanthin, S_{47} for yellow xanthophyll and carotenoid hydrocarbon). The results are summarized in Tables 4, 5 and Fig. 5.

Table 4. The optical density of astaxanthin, yellow xanthophyll and carotenoid hydrocarbon fraction.

Species	Optical density		
	Esterified xanthophyll		Carotenoid hydrocarbon
	Astaxanthin	Yellow xanthophyll	
Parabembras curtus	0.995	0.040	—*
Lepidotrigla microptera	0.680	0.135	—*
Sebastes inermis	1.250	0.260	0.040
Taius tumifrons	0.255	0.170	—*

* Carotenoid content was too minute to determine.

Table 5. Relation between the colour of skin and fins, and the ratio of optical density of astaxanthin to yellow xanthophyll.

Species	Colour of skin and fins	$\frac{\text{Optical density of astaxanthin}}{\text{Optical density of yellow xanthophyll}}$
Parabembras curtus	Red	24.9/1
Lepidotrigla microptera	Orange-red	5.0/1
Sebastes inermis	Dirty brown-red	4.8/1
Taius tumifrons	Yellow-pink	1.5/1

Summary

The distribution of carotenoids in the skin and fins of four species of marine fish has been examined. The amount of free xanthophyll and carotenoid hydrocarbon was minute and the esterified xanthophyll was dominant. Esterified xanthophyll was divided into two fractions ; a red xanthophyll which was recognized to be esterified astaxanthin and a yellow xanthophyll resembling sarcinaxanthin in the absorption maxima.

These two carotenoids were the principal pigment component of the skin and fins of each species. The relationship between the colour of the skin and fins of these fishes and the concentration of the two principal carotenoids was examined.

Acknowledgment

The author wishes to express his deep gratitude to Professor Y, NAKAMURA and Professor T. SAITO of Hokkaido University for their encouragement and guidance. The author is also grateful to Professor S. MIZUHARA of Okayama University for permission to use autorecording Beckman electric spectrophotometer and to Dr. H. UTINOMI of Seto Marine Biological Laboratory of Kyoto University who gave the opportunity for publication.

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EXPLANATION OF PLATE XXX

Fig. 1. Astacene from the skin and fins of *Parabembras curtus.*

Fig. 2. Astacene isolated from a crustacean decapod *Linuparus trigonus* VON SIEBOLD.

Fig. 3. Astacene from the skin and fins of *Lepidotrigla microptera.*

Fig. 4. Astacene from the skin and fins of *Sebastes inermis.*

Fig. 5. Astacene from the skin and fins of *Taius tumifrons.*

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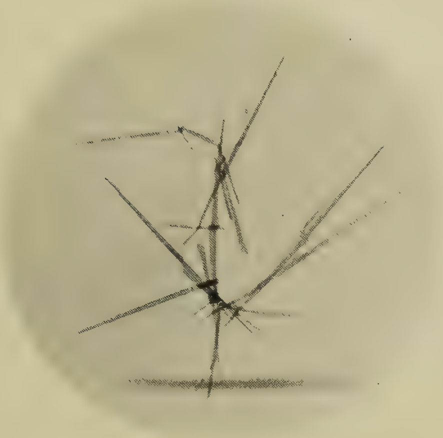

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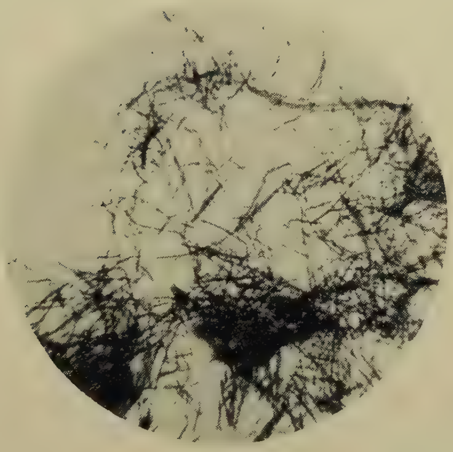

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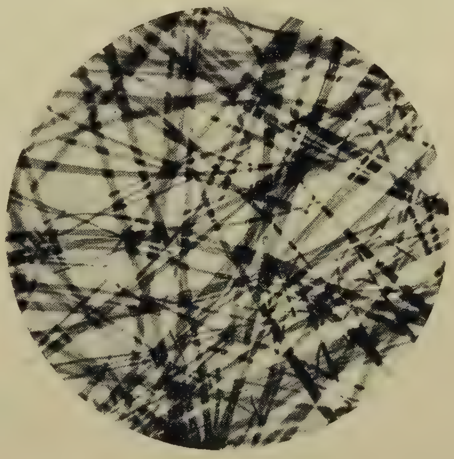

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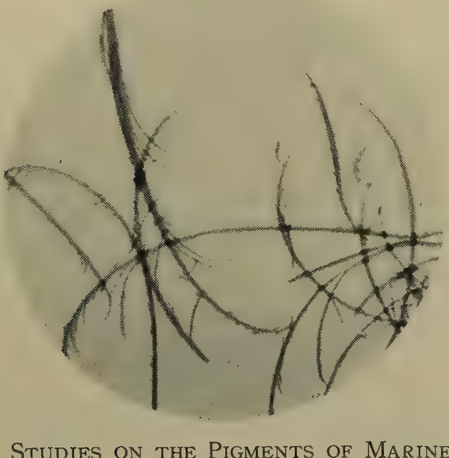

OBSERVATIONS ON THE TAXONOMY AND DISTRIBUTION OF CHAETOGNATHS OF THE NORTH PACIFIC[1]

TAKASI TOKIOKA

Seto Marine Biological Laboratory, Sirahama

With 35 Text-figures and 74 Tables

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[1] Contributions from the Seto Marine Biological Laboratory, No. 339.

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Introduction

Although I had a chance to look through a part of vast collection of plankton samples kept at the Scripps Institution of Oceanography and to examine a considerable number of specimens of chaetognaths during my stay there in 1956—57, I have refrained from publishing papers on this animal group, because I knew at that time that Mr. R. Bieri had already accumulated a great many data on chaetognaths during his long stay at Scripps and had begun to prepare manuscripts for publication. Now, two of his papers (1957 and 1959) have been published on the Pacific chaetognaths. The second paper is especially very important in giving a comprehensive outline of the distribution of different species in the North Pacific. Previous works on Pacific chaetognaths are all covered in the second paper. Five subsequent papers on the Pacific chaetognaths have appeared, two by Fagetti (1958 a, b) on material from Chilean waters and three by Sund (1959 a, b, c) on material from the Gulf of Alaska and eastern tropical waters.

My data shown in the tables appended at the end of this article appear to contribute only supplemental information to the distribution-charts of the respective species as given by Bieri (1959), but the results of closer morphological examinations on the material comprise some new findings. A new species and a new form was found in the material from the eastern tropical Pacific. The *tenuis-friderici* problem is discussed again on Pacific specimens, the range of morphological variations is reviewed in some species and a few morphological notes on some additional species are presented. In addition, the relative abundance of the four important species (*Sagitta enflata*, *S. serratodentata pacifica*, *S. hexaptera* and *Pterosagitta draco*) is defined by computing ratios between *S. enflata* and each of *serratodentata pacifica*, *hexaptera* and *P. draco*. This procedure seems to indicate a relation between the chaetognath fauna and some water-masses more clearly than previously shown. The distribution of *Sagitta bedoti* in the western Pacific and the Indian Ocean is reviewed in detail on the basis of present material and also on previous records published to date. This leads to the conclusion that a characteristic water mass of comparatively large extent, the *bedoti*-water, can be defined distinctly in the Indo-Pacific.

Before going further, I want to express my hearty thanks to the staff of the Scripps Institution of Oceanography for granting me the favour of a seat at the laboratory for a year, especially to Prof. M. W. Johnson for his kindness in providing facilities and for reading the manuscript ; and also to the Rockefeller Foundation for a postdoctoral fellowship.

Material and Methods

The material examined consists of the following 326 plankton samples:

1. Transpac Expedition 1953: 130 samples collected from 50 m to the surface by means of a small net having a 17 cm diameter mouth; 19 samples collected by a Japanese survey ship off north eastern Honsyû, Japan were presented to the research party of the Expedition. These samples were taken vertically from 50 m to the surface by using KITAHARA's quantitative net, a small modified HENSEN's net. A sample of the North Pacific Stranger Expedition (1955) was examined and the result is given at the end of the table of the Transpac Expedition.
2. Midpac Expedition 1950: 57 samples taken by various gears and also from various depths.
3. Shellback Expedition 1952: 48 samples, one of every five stations, were examined. The samples were collected with a large net from about 300 m to the surface.
4. Equapac Expedition 1956: Five of many samples were examined; they were taken with a large net from 200–400 m to the surface.
5. The blue-green water survey: 54 samples taken with a small net, having a 17 cm diameter mouth; of these 35 were collected off San Diego, and 19 were collected March 12–13, 1956 in the area extending from San Diego to Long Beach.
6. Lagoon samples: Ten samples from Scammons lagoon, Oct. 9–12, 1955 and two samples from Manuela lagoon, Oct. 12, 1952. All these samples were collected by members of the Foraminifera Laboratory of the Scripps Institution of Oceanography under the direction of Prof. F. B. PHLEGER. I am very grateful to Prof. PHLEGER and the members of the Laboratory for their kindness in allowing me to examine these samples and to quote some of the hydrographical data in this paper.
7. In addition, the data obtained by examining the samples collected during the Palao-New Guinea cruises 1940 made by the former Japanese fisheries experimental station at Palao are given herewith.

In treating the samples collected with small nets, the whole of each sample was examined with a magnification of 30×. Every individual of each species was identified carefully and counted. In treating the large net samples, however, only one fourth of each sample was examined in this way. The crude data, thus obtained, are arranged in 8 tables appended at the end of this paper. In measuring the body length or the length of the caudal segment, the caudal fin was always included. When the teeth were counted, the anterior portion of the head was dissected off under the binocular, the dental area was mounted and examined under the microscope. The corona ciliata was observed by staining it with rose bengal; the existence of the intestinal diverticula was ascertained by making the specimens transparent with glycerine and examining them under the microscope. The arrangement of fin rays and the number of eggs were determined under the microscope. When it was necessary to measure some small distances, the objects were drawn on a sheet of paper by using a camera lucida and the measurements were made from these sketched figures. In computing percentages, ratios and means, fractions less than 1/2 were disregarded and the rest were counted as units.

Taxonomy

In all, the following 30 forms were identified in the whole series of samples:

1. *Sagitta hexaptera* D'ORBIGNY
2. *Sagitta lyra* KROHN
3. *Sagitta enflata* GRASSI
4. *Sagitta enflata* f. *gardineri* DONCASTER
5. *Sagitta elegans* VERRILL
6. *Sagitta bipunctata* QUOY et GAIMARD
7. *Sagitta ferox* DONCASTER
8. *Sagitta ferox* f. *americana* nov.
9. *Sagitta robusta* DONCASTER
10. *Sagitta bedoti* BÉRANECK
11. *Sagitta pulchra* DONCASTER
12. *Sagitta tenuis* CONANT
13. *Sagitta friderici* RITTER-ZÁHONY
14. *Sagitta serratodentata pacifica* TOKIOKA
15. *Sagitta serratodentata pseudoserratodentata* TOKIOKA
16. *Sagitta serratodentata tasmanica* THOMSON
17. *Sagitta neglecta* AIDA
18. *Sagitta oceania* GRAY
19. *Sagitta regularis* AIDA
20. *Sagitta bedfordii* DONCASTER
21. *Sagitta crassa* f. *naikaiensis* TOKIOKA
22. *Sagitta minima* GRASSI
23. *Sagitta decipiens* FOWLER
24. *Sagitta neodecipiens* n. sp.
25. *Sagitta planctonis* STEINHAUS
26. *Sagitta macrocephala* FOWLER
27. *Pterosagitta draco* (KROHN)
28. *Eukrohnia hamata* (MÖBIUS)
29. *Krohnitta subtilis* (GRASSI)
30. *Krohnitta pacifica* (AIDA)

Most of these species have been described repeatedly and a key to the tropical eastern Pacific Ocean species has been published by SUND (1959b). Hence, only descriptions of two new forms and some notes on problematic forms or on the range of variations will be given together with a few morphological notes. Three subspecies of *Sagitta sessatodentata* KROHN are printed in tables as species in order to save space.

1. *Sagitta ferox* f. *americana* nov.

(Figs. 1–3, Tables 1–4)

A medium-sized species attaining 8.3 mm in body length of which the tail segment constitutes most frequently 27–29%. General appearance of the body and the relative size of the head resemble closely those of the typical *S. ferox*, from which it is very difficult to separate even under considerably high magnification. The head is medium in size, not so large as in *S. robusta*; neck distinct, no constriction at the trunk-tail septum. The collarette is fairly conspicuous at the neck region and reaches to the anterior end of the ventral ganglion, diminishing in thickness posteriorly. The anterior fin begins at the posterior end of the ventral ganglion and without any rayless zone. The posterior fin is a little longer than the anterior and more than half of the fin lies on the tail segment, being widest at the level slightly posterior to the trunk-tail septum; rayless zone is practically absent, except for a very narrow rayless area in front of the aperture of the female genital organ in some individuals. The distance between the anterior and posterior fins is approximately one fourth of the posterior fin. Eye-pigment is rather large, slightly elongate and curved. The corona ciliata (Fig. 1) begins at the posterior margin of the brain in front of eyes, it is about one and a half times as long as the head, and both sides are slightly sinuous; this is slightly shorter than in *S. robusta*. The intestinal diverticula are present and very distinct. Hooks are most frequently 7–8 in adults, though they fluctuate from 6 to 9. The anterior teeth are slender and only slightly fewer than the posterior teeth which are much thicker and usually 10–12 in number (fluctuate from 9 to 14) in mature individuals. Frequently the anterior teeth may equal, or in some cases, exceed the posterior teeth in number. This was observed only in mature specimens larger than 6.7 mm (in 12 of 22 specimens examined longer than 6.7 mm). The difference in number between the anterior and posterior teeth is larger in smaller immature individuals than in mature ones. Rows of the anterior teeth usually meet

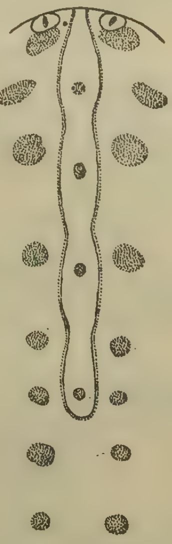
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Fig. 1. 1—*Sagitta ferox* f. *americana* n. f. Corona ciliata (SB 20).

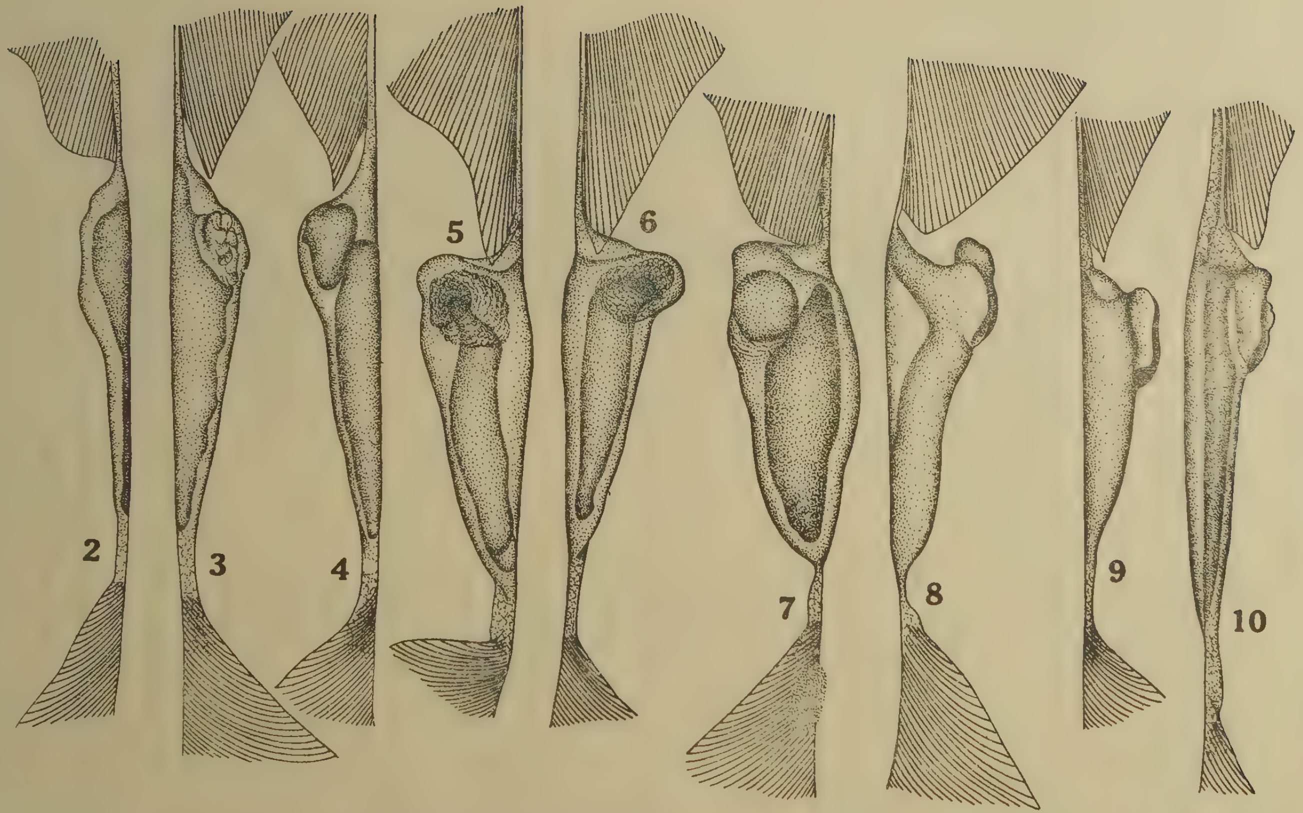

Fig. 2. *Sagitta ferox* f. *americana* n. f. Seminal vesicles arranged in the order of maturity. ×125; 2–4—(SB 20), ventral; 5–6—(SB 60), ventral; 7—(SB 20), ventral; 8—6.8 mm long individual (SB 210), 9—ruptured (SB 60), ventral; 10—ruptured (SB 60), dorsal.

in an acute angle, but in obtuse angles on some widely expanded heads. Both hooks and teeth are brownish. Fully mature ovaries reach near the neck. The seminal vesicle (Fig. 2) is situated very near the rear end of the posterior fin, being slightly apart from the base of the tail fin. The distance between the vesicle and the tail fin is, however, very small and also very variable. In some cases, it is practically indiscernible, while in others it may reach up to 24% of the length of the vesicle; thus the ratio, the distance between the vesicle and the tail fine/the vesicle length, fluctuates from 0 to 0.24, being 0.14 on an average of 12 measured individuals. In structure the vesicle consists of a glandular anterior portion and a voluminous posterior sperm sac which can be seen clearly when the specimen is examined in the light field under the microscope. But externally, the distinction between the anterior and posterior portions of the vesicle is indistinct. Thus, the situation and the outline of the vesicle resemble more closely those of *S. robusta* rather than those of *S. ferox*, although the fully mature vesicles are more voluminous than in *S. robusta*. Rupture occur at the antero-lateral side. The seminal vesicle of typical *ferox* usually touches both the posterior and tail fins (the distance between the vesicle and tail fin/the vesicle length may reach 0.12 in some cases) and consists of a very conspicuous anterior glandular portion and a posterior saccular portion. There is also a swelling of the frothy tissue just in front of the vesicle in perfectly preserved specimens (Fig. 3); this swelling is quite absent in the present form and also in *S. robusta*. The ovary reaches to the anterior end of the posterior fin in a 5.5 mm long individual, to the ventral ganglion in a 6.2 mm long individual and near the neck in a 6.4 mm long individual. Fully swollen seminal vesicles are found on a 6.2 mm long individual.

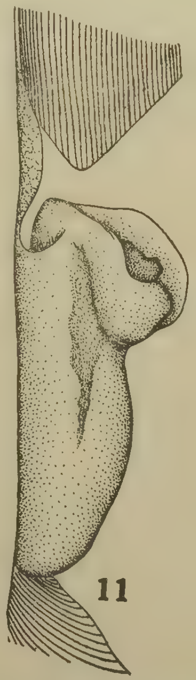

Fig. 3. *Sagitta ferox* DONCASTER. Seminal vesicle of a 6.7 mm long individual. ×125 (EQP H-3)

Remarks: The armature formulae of *S. robusta* are closely related to those of the present form, although the hooks are most frequently 6 (5–7) in mature *robusta* and the difference in number between the anterior and posterior teeth is slightly larger in *robusta* than in the present form; besides both hooks and teeth of *robusta* yellowish rather than brownish. The shape and situation of the seminal vesicle of *robusta* resemble closely those of the present form. In spite of these resemblances, these two forms can be separated from each other distinctly by the size of the head which is exceedingly larger in *S. robusta*. *Sagitta hispida* CONANT from the Caribbean Sea, especially some of the specimens described by SUAREZ (1955) from Cuban waters, is also closely related to the present form, the number of hooks and teeth

1 Sag ferox f americana

No	body length	tailseg. in %	hook	ant. teeth	post. teeth	maturity	loc
1	3.6mm	33.9	9—9	4—5	6—6	im.	SB75
2	4.2	31.3	9—9	1+*—5	8—8	im.	SB75
3	4.5	29.0	7—8	4—5	8—8	im.	SB68
4	5.5	27.1	7—7	8—8	10—10	med.	SB55
5	5.9	28.6	6—7	7—7	11—12	med.	SB55
6	5.9	27.8	7—7	7—7	10—10	med.	SB75
7	6.0	26.9	7—7	7—7	9—10	med.	SB64
8	6.2	29.5	7—7	9—9	10—12	m.	SB64
9	6.2	26.3	7—7	7—7	9—10	m.	SB210
10	6.4	30.6	6—7	8	9	m.	SB30
11	6.6	26.7	6—6	7—8	9—10	m	SB55
12	6.7	29.1	7—7	10—11	10—10	m.	SB60
13	6.8	28.6	8—8	10—10	10—10	m.	SB210
14	6.8	26.7	7—7	12—13	10—10	med.	SB71
15	6.9	28.3	7—7	10—10	10—11	m.	SB60
16	7.0	26.9	7—7	12—12	12—13	m.	SB60
17	7.2	29.1	8—8	9—9	11—12	m.	SB64
18	7.3	28.6	7—8	9—7	9—11	m.	SB64
19	7.3	26.5	6—6	8—8	9—10	m.	SB71
20	7.3	26.5	7—8	9—11	10—10	m	SB71
21	7.5	26.1	7—7	5+*—10	10—10	m.	SB64
22	7.5	26.1	7—7	3+*—9	5+*—10	med.	SB64
23	7.6	29.9	7—7	7	12	m.	SB30
24	7.7	27.7	7—7	9—9	11—12	m.	SB60
25	7.7	28.6	7—7	9—10	12—13	m.	SB71
26	7.7	27.7	8—8	10—14	11—11	m.	SB75
27	7.8	30.8	7—7	9	11	m.	SB30
28	7.8	27.5	7—7	10—11	10—10	m.	SB68
29	7.9	28.1	7—7	10—11	10—11	m.	SB68
30	7.9	25.6	8—8	9—9	10—10	m.	SB160
31	8.0	27.6	7—8	10—11	11—11	m.	SB68
32	8.2	28.6	6—7	8—8	10—10	m.	SB175
33	8.3	27.6	7—7	10—10	13—14	m	SB175

Table 1. Armature formulae of *S. ferox* f. *americana* n.f.
* Some torn out. SB⋯Shellback Exp.

seems to fall in the range of the variations found in the present form, although the anterior teeth are always slightly fewer than the posterior ones. Mature *S. hispida* are, however, larger than mature specimens of the present form, the ovary dods not reach beyond the frontal end of the anterior fin and the shape of the seminal vesicle resembles that of *S. bedoti* and is separated from the caudal fin by about half the length of the vesicle. Although the general appearance of *S. ferox* resembles that of the present form, the anterior teeth are much fewer by about one half than the posterior teeth. The structure and situation of the seminal vesicle also differ slightly. Most probably, *S. robusta, hispida, ferox* and the present form have differentiated from a common ancestor and are very closely related. At present, I can not judge whether the present form is a distinct species or a variety or merely a form of any already known species. Here I can only treat the present form provisionally

2 Sag. ferox

No.	body length	tail seg. in %	hook	ant. teeth	post. teeth	maturity	loc
1	6.7mm	29.1	8—8	6—7	14—14	m.	EQPH3
? 2	7 8	28.3	8	6	14	im.	SB 30
3	8.5	30.8	9—9	6—7	14—14	m.	EQPH 17

3 Sag. robusta

No	body length	tail seg. in %	hook	ant teeth	post. teeth	maturity	loc
1	4 6mm	28.6	7—7	5—5	7—8	im.	SB 75
2	6 3	27.8	7—7	5—5	8—8	im.	SB 75
3	6.5	31.0	6—7	6—6	9—11	im.	SB 71
4	8 5	29.0	7—7	7—8	12—12	im.	SB64
5	8.5	27.5	6—6	8—8	12—12	im.	SB95
6	10.4	25.0	6—6	7—8	12—12	m	SB71
7	11 1	29.4	6—6	7—8	12—12	m.	SB64
8	15.0	26.1	6—6	6—7	10—10	m.	SB105

4 Sag. robusta collected by Paul N. Sund (Scot sta.23)

No	body length	tail seg. in %	hook	ant teeth	post teeth	maturity
1	9.5mm	28.4	6—6	8	13	im
2	11 5	26.1	7—7	10	13	im
3	12.0	27.5	6—6	10	13	im
4	12 7	29 9	6—6	10	13	im

Tables 2–4. Armature formulae of *S. ferox* (2) and *S. robusta* (3–4).
EQP···Equapac Exp., SB···Shellback Exp.

as a local form specialised from *S. ferox* and restricted to the Shellback area*, since the general appearance of both forms resemble each other so closely. *Sagitta helenae* RITTER-ZÁHONY conforms to the present form in that the anterior teeth are numerous and usually exceed the posterior ones, but the difference between the two is very distinct, because the former, *S. helenae*, is quite devoid of the intestinal diverticula.

2. *Sagitta tenuis* CONANT and *Sagitta friderici* RITTER-ZÁHONY

(Figs. 4–5, Tables 5–8)

Specimens of *S. tenuis* from Scammons and Manuela lagoons (Fig. 4) are less than 10.7 mm in body length and the tail segment occupies about 30% of the total body length. The body is rather rigid and provided with many tactile setae distributed over the body surface and thus assumes a hispid appearance. Collarette is

5 Sag tenuis from Scammons Lagoon

No	body length	tail seg in %	hook	ant teeth	post. teeth	maturity	TC
1	3.8mm	31.0	8—9	3—4	6—6	im.	66.7
2	4.4	26.5	8—9	3—3	4—4	im.	83.3
3	5.3	32.1	8—8	4—4	7—7	med.	65.8
4	5.3	26.5	8—8	3—4	7—7		64.1
5	5.5	31.8	8—8	4—4	7—7	med.	63.4
6	5.7	34.7	8—8	4—4	6—7		63.3
7	6.0	32.6	8—8	4—4	8—8	m.	69.0
8	6.2	29.5	8—8	5—5	8—8	med.	71.8
9	6.2	30.5	8—8	5—5	9—9	med.	68.9
10	6.2	31.3	7—8	5—5	10—10	med.	60.9
11	6.4	32.3	8—8	5—5	9—9	med.	60.4
12	6.6	30.7	8—8	5—5	9—10	med.	66.7
13	7.0	30.6	8—8	5—5	10—10	m.	66.7
14	7.1	29.4	8—8	4—4	11—11	med.	73.3
15	7.2	25.5	8—9	5—5	9—9	med.	62.5
16	7.2	29.1	7—7	4—5	[illegible]	m.	70.0
17	7.4	26.3	7—8	5—5	11—11	m.	62.5
18	7.5	29.6	8—8	6—6	13—13	m.	84.4
19	7.5	30.4	7—7	5—5	10—10	m.	73.3
20	7.5	28.4	8—8	5—5	11—11	m.	70.0
21	7.8	30.1	8—8	5—6	12—12		70.2
22	7.8	29.2	7—8	5—5	11—11	m.	63.6
23	8.6	28.9	9—9	7—7	14—14	m.	66.9
24	10.7	29.0	8—8	5—5	12—12	m.	91.5

Table 5. Armature formulae of *S. tenuis* from Scammons lagoon.

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* The area surveyed by the Shellback Expedition 1952, see Fig. 25.

distinct near the neck. The anterior fin begins usually at the posterior end of the ventral ganglion, but in larger individuals there is a space of about one half of the ganglion length between the frontal end of the fin and the posterior end of the ganglion. Fin rays are all arranged obliquely towards the posterior; rayless-zone absent. The posterior fin is nearly as long as the anterior and widest at the level posterior to the trunk-tail septum; fin rays are arranged as on the anterior fin, although those near the frontal end are vertical to the base of the fin or even arranged slightly obliquely towards the anterior. Eye-pigments roundish. The corona ciliata is about twice the head length, with two shallow sinuses along each side. The intestinal diverticula absent. The ovary extends slightly beyond the anterior end of the posterior fin at maturity. Ova are usually arranged in two, dorsal and ventral, rows in each ovary and mostly 14–20 in number in each, the maximum observed was 24 in the 10.7 mm long individual. The seminal vesicle is elongate, rather low and with the anterior glandular portion slightly swollen. It touches both the posterior and caudal fins. The ratio TC (anterior part of the posterior fin along the trunk/posterior part of the posterior fin along the caudal segment ×100) varies from 60.4 to 91.5, being 69.1 on an average of 24 specimens. The above-mentioned features together with the armature formulae (Table 5) evidently refers the specimens to *Sagitta tenuis*. Rows of anterior teeth meet each other in acute angles.

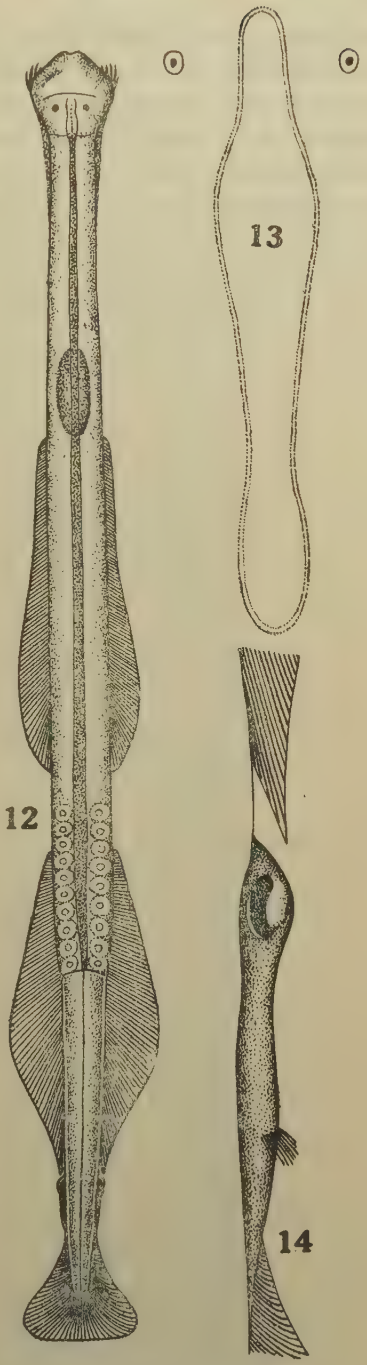

Fig. 4. *Sagitta tenuis* CONANT. A 8.6 mm long individual from Scammons Lagoon. 12—Dorsal side of the animal, ×20; 13—Corona ciliata, 14—Seminal vesicle.

Other chaetognaths found in the blue-green water along the southern Californian coast and in some samples of the Transpac and Shellback Expeditions, collected at stations near this blue-green water region, seem to belong to *Sagitta friderici*. They resemble closely *S. tenuis*, but differ from that species in the following points :-

1) mature individuals are larger, attaining 12.8 mm in length; tail segment is slightly shorter, 26.2% on an average of 34 measured individuals; 2) both the anterior and posterior teeth are fewer than in *S. tenuis* of the same body length; and 3) TC value is much larger, varying from 76 to 141.7 and 106 on an average of 33 measured specimens.

In addition, there are a number of specimens from offshore waters in the Shell-

6

No.	body length	tail seg. in %	hook	ant. teeth	post. teeth	mat.	TC	loc.
1	3.7 mm	28.1	9—9	2—2	3—3	im.	76.0	TP
2	4.2	30.8	9—9	3—3	4—4	im.	80.0	TP
3	4.4	26.9	9—9	2+*-3	5—5	im.	82.8	TP
4	4.9	28.9	8—8	2—3	4—4	im.	85.7	SD
5	5.1	28.2	8—8	3—?	5—5	im.	88.2	TP
6	5.1	30.4	8—9	2—3	5—5	im.	89.9	SB 5
7	5.2	27.5	8—9	3—3	4—4	im.	83.3	SD
8	5.3	28.0	9—9	2—3	5—5	im.	91.4	TP
9	5.3	26.8	8—9	3—3	7—7	im.	88.2	TP
10	5.5	27.1	9—9	2—3	5—5	im.	94.3	TP
11	5.7	28.4	7—8	3—3	5—5	im.	101.6	SB 5
12	5.8	29.2	9—9	2—3	6—7	im.	89.7	SB 5
13	5.9	27.8	8—9	1+*-3	7—7	im.		SB 5
14	6.0	25.8	9—9	2—2	5—5	im.	100.0	SD
15	6.3	25.7	6—7	3—4	7—8	im.	122.8	SB 5
16	6.5	27.0	7—8	5—5	7—7	im.	87.1	SB 5
17	6.5	30.0	6—7	5—5	8—8	im.	100.0	SB 5
18	6.5	26.0	7—7	4—4	7—7	im.	106.3	SB 5
19	6.6	27.4	7—8	3—3	7—7	im.	108.6	SB 5
20	6.7	24.6	9—9	2—3	6—6	im.	105.3	TP
21	7.1	26.6	7—7	5—5	9—9	im.	133.3	SB 85
22	7.2	23.4	8—9	3—3	5—5	im.	119.0	SD
23	7.3	23.2	8—8	4—4	8—8	im.	105.0	TP
24	7.5	26.1	10—10	3—4	8—8	im.	119.0	TP
25	7.5	26.1	8—9	4—4	7—7	im.	114.3	TP
26	9.4	23.6	7—9	4—5	8—9	med	134.0	SD
27	10.4	25.0	8—8	5—5	11—11	med	121.8	TP
28	10.6	23.9	8—8	4—5	9—10	med	120.4	SD
29	11.0	24.9	8—8	5—6	11—11	med	100.0	SD
30	11.5	23.2	8—8	6—6	13—13	med	125.0	SB 1
31	11.6	22.5	8—8	6—6	11—11	med	136.4	SB 1
32	11.6	24.2	8—9	6—6	12—12	med	114.1	SD
33	12.0	22.7	8—9	7—7	12—14	med	133.3	SB. 1
34	12.8	20.8	8—8	4—4	11—12	med	141.7	SB 1

Table 6. Armature formulae of *S. friderici* from the blue-green water.
* Some torn out. TP···Transpac Exp., SB···Shellback Exp., SD···San Diego.

back samples, which superficially closely resemble *S. friderici*. Close examination reveals that they do not agree in the armature formulae with the typical *S. friderici* collected from the San Diego region. The anterior and posterior teeth are more abundant in these. Roughly speaking, these chaetognaths can be divided into two groups, one with 7–8 (or 9) hooks (group A) and the other with 5–6 hooks (group B). The armature formulae of the former (group A) resembles somewhat those of *S. tenuis*. The ratio TC is relatively small, varying from 80 to 91.1 and 86.3 on an average of eleven measured specimens, while in group B it is slightly higher, varying from 88.4 to 114.3 and 96.6 on an average of 13 measured specimens. When the

7 Shellback specimens allied to S.friderici

No.	body length	tail seg. in %	hook	ant. teeth	post teeth	mat.	T C	loc.
1	6.2 mm	29.5	7—7	6—6	10—10	im.	85.7	SB 112
2	6.4	25.5	7—9	6—6	14—14	im.		SB 109
3	7.2	27.3	6—6	7—7	14—14	med.	88.4	SB 100
4	7.5	27.0	6—6	7—7	14—14	med.	97.5	SB 5
5	7.5	26.1	5—6	7—7	14—14	m.	95.0	SB 90
6	7.6	27.4	7—8	6—6	12—12	im.		SB 5
7	7.7	28.0	6—6	7—7	14—14	im.		SB 109
8	7.7	28.6	6—6	7—7	15—17	med.		SB 95
9	7.8	29.2	6—6	7—8	14—15	m.	100.0	SB 85
10	7.8	28.3	5—6	8—8	15—16	m	93.3	SB 90
11	7.9	26.2	6—6	6—6	13—13	im.	100.0	SB 105
12	8.1	25.6	6—6	7—7	16—16	m	107.5	SB 50
13	8.1	27.2	6—6	6—6	13—13	im.	93.0	SB 105
14	8.1	27.2	8—8	7—7	15—15	im.	86.0	SB 112
15	8.1	28.0	6—6	8—8	15—16	m		SB 85
16	8.3	29.1	6—6	7—7	15—15	med.	88.9	SB 105
17	8.3	25.8	7—7	4+*—6	12—13	im.	91.1	SB 105
18	8.5	26.9	6—6	7—7	14—14	m		SB 5
19	8.5	29.2	6—6	7—7	16—17	m	91.3	SB 105
20	8.7	29.1	6—6	6—7	13—14	im	90.9	SB 105
21	8.8	26.5	6—6	7—8	16—16	m.	96.2	SB 1
22	8.8	29.6	6—6	7—7	15—16	im.		SB 90
23	9.4	28.5	6—6	8—9	18—19	im.	114.3	SB 109
24	10.0	26.6	8—8	8—9	16—18	im.	83.3	SB 118
25	11.1	24.1	8—8	5+*—9	17+*—19	m.	89.2	SB 109
26	11.4	27.4	8—8	9—9	17—18	med.	88.7	SB 122
27	11.7	25.6	8—8	7—11	20—22	med.	81.3	SB 109
28	12.0	26.1	8—8	6+*—11	21—23	m.	90.7	SB 109
29	13.0	25.0	8—8	10—10	21—22	m.	80.0	SB 109
30	13.2	26.1	8—8	10—11	24—24	m.	87.5	SB 109
31	13.8	25.5	7—8	10—10	25—25	med.	85.7	SB 109

Table 7. Armature formulae of the Shellback specimens allied to *S. friderici*.
* Some torn out. SB···Shellback Exp.

ratios TC of all of the above-mentioned forms, of course including both typical *S. tenuis* and *S. friderici*, are plotted on a graph (Fig. 5) and the relative position of values in respective groups are compared, then the idea that group A with 7–8 hooks may be identified as *S. tenuis*, seems possible. Theoretically it is not impossible that *S. tenuis* propagated in some embayments might be drifted out, the attainment of sexual maturity in these might be much retarded by environmental changes so they might grow to such very large size as 13.8 mm, which is evidently an exceptional length for *S. tenuis*. The increase of the body length in waters of lower temperature is not rare in species of chaetognaths. The anterior and posterior teeth might increase with body length. A flow of water out into the open sea from embayments in tropical area usually results in a remarkable drop in temperature. However, there remains still a gap of considerable width on the graph between the group of the typical *S. tenuis* and that of group A. *Sagitta bipunctata* also resembles superficially group A. But it has usually 8–9 (though fluctuating from 7 to 10) hooks and slightly fewer anterior and posterior teeth (Table 8), and also somewhat elongate eye-pigments. In the armature formulae given by Sund (1959b), the number of hooks seems to

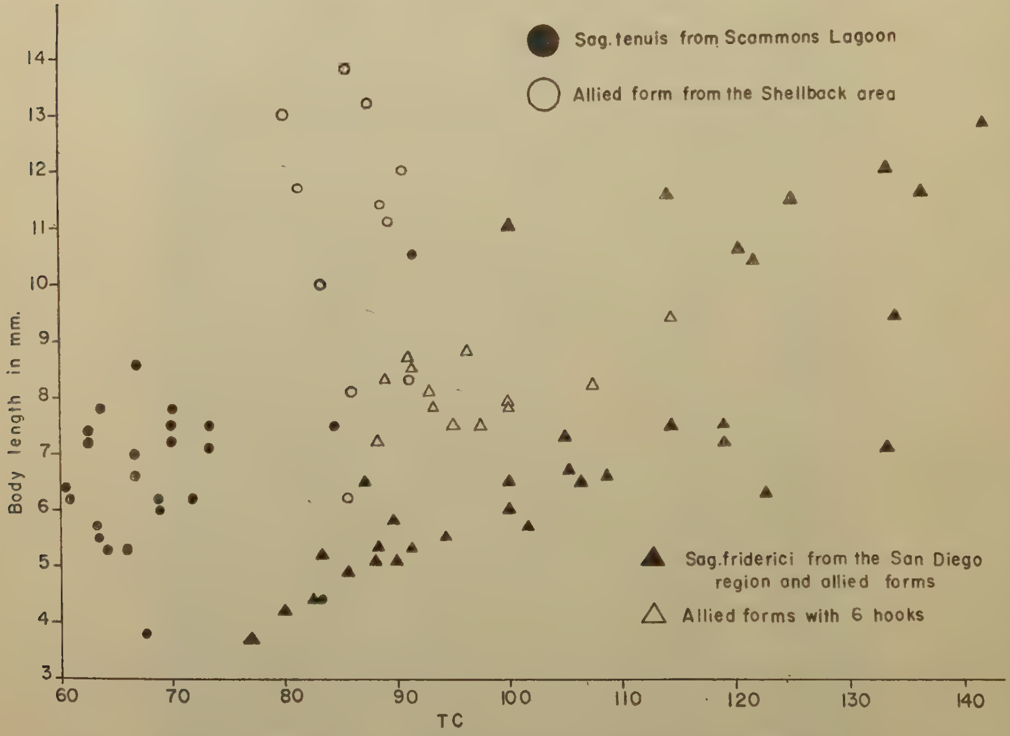

Fig. 5. Ratio TC (anterior part of the posterior fin along the trunk/posterior part of the posterior fin along the caudal segment ×100) of *Sag. tenuis*, *Sag. friderici* and their allied forms from the Shellback area.

be rather fewer than usual. The body is slightly stouter than in *friderici* and the collarette seems to be more conspicuous. For a detailed comparison between these two species, the comprehensive work done by FAURE (1952) is available. *Sagitta bedoti* is also superficially related closely to group A, but this species is most frequently provided with 7 hooks and its fins are marked with conspicuous rayless zones. A careful comparison was also made between group A and *Sagitta crassa* f. *naikaiensis*, although the locality of the latter is far removed from the Shellback area. However, the absence of intestinal diverticula in the former denies absolutely a close relationship between these two forms. The distance between the eyes is relatively large in both groups A and B, distance/head width ×100 is 36.2–47.5 (42.3 on an average of 6 measured specimens) in 8.1–13.8 mm long individuals and this feature seems to increase the superficial similarity between forms A and B and *S. bedoti* or *S. crassa*.

8 Sagitta bipunctata

No.	body length	tail seg. in %	hook	ant teeth	post. teeth	maturity	loc
1	3.9mm	33.3	9—9	3—3	7—7	im.	SB 75
2	3.9	30.0	9—9	5—5	8—8	im.	SB 60
3	6.8	27.6	8—9	7—7	14—15	im.	SB 75
4	7.2	27.3	8—9	5—6	11—11	im.	SB 25
5	8.1	28.0	9—9	6—6	12—12	med.	SB 64
6	9.2	26.2	9—10	7—7	3—15	med.	SB 60
7	9.5	29.5	10—10	7—8	14—15	m.	SB 71
8	9.8	26.7	9—9	6—7	15—16	m.	SB 71
9	9.8	27.3	9—9	8—8	15—16	m.	SB 55
10	9.9	26.1	10—10	8—8	14—15	m.	SB 60
11	9.9	26.1	8—8	7—9	14—15	m.	SB 160
12	10.1	27.7	10—10	9—9	14—15	m.	SB 75
13	11.1	25.9	10—10	7—7	16—17	m.	SB 175

Table 8. Armature formulae of *S. bipunctata*.
SB···Shellback Exp.

The ovary at its maximum length reaches to the middle of the anterior fin in group A and to the frontal end of the posterior fin in group B. Group B is very peculiar in having fewer hooks and therefore compared with *S. bedoti*, *S. decipiens* and *S. neodecipiens*, both of which are provided most frequently with only 6 hooks. However, the eye-pigments of these two species are elongate and much larger than that of group B. Moreover, the intestinal diverticula are present in these two species. On the other hand, 6 hooks, up to 8 anterior teeth and up to 20 posterior teeth are included in the range of variations found by previous authors in the armature formulae of *S. friderici*. It is evident that *S. friderici* shows a wide range of diversity in the armature formulae according to localities. Consequently it is not strange that some differences are found in the number of hooks and teeth between specimens of *S. friderici* collected in the San Diego region and those from the Shellback area.

And the Shellback area itself is very extensive and as a result it is quite possible that there exist different stocks of *S. friderici*, which might show respectively different armature formulae or TC ratios. Therefore it is not improbable that groups A and B represent only different stocks of *S. friderici*, both distinctly differing from the specimens occurring in the San Diego region, because the localities of the groups A and B are somewhat apart from each other. If the mature seminal vesicles were found in some specimens of these two groups, then the above-mentioned problem would be settled very easily and decidedly. Unfortunately, however, every specimen of groups A and B is devoid of seminal vesicles, hence, at present, only their probable systematic relationships are explained, together with *S. tenuis* and *S. friderici*. As to *S. tenuis* and *S. friderici*, I can only say that speciation in these two forms seems not to have evolved so far from a common ancestor, but I cannot determine whether the degree of speciation is at the level of species or variety. I am of the opinion that they are not ecological forms of a single species, because intermediate forms are not yet known from the waters showing intermediate characteristics between the *tenuis*-and *friderici*-waters.

3. *Sagitta serratodentata tasmanica* THOMSON

(Figs. 6–12, Tables 9–11)

THOMSON (1947) : Commonwealth of Australia, Council for Scientific and Industrial Research Bulletin No. 222, pp. 15–17, 1 text-fig.

Sagitta tasmanica...FURNESTIN (1953 a) : Bulletin de l'Institut Océanographique, No. 1025, 39 pp.
FURNESTIN (1953 b) : Bulletin des Travaux publiés par la Station d'Aquiculture et de Pèche de Castiglione (Alger), Nouvelle serie, No. 4, p. 25.
FAGETTI (1958) : Revista de Biologia Marina (Valparaiso), Vol. VIII, Nos. 1–3, pp. 46–48, text-fig. 7.

Sagitta sp. (*serratodentata* group)...BIERI (1959) : Limnology and Oceanography, Vol. IV, No. 1, p. 18, text-fig. 22.

Many specimens up to 15 mm from the Shellback area and a single specimen from St. 1 of the Transpac Expedition. Generally speaking, the body appears to be a little more transparent than in *S. pacifica*; the hooks and the anterior and posterior teeth are yellowish, but stained more faintly than in *pacifica* and the serration on the hooks is not so conspicuous as in *pacifica*. The frontal end of the anterior fin begins at about the posterior end of the ventral ganglion. The anterior part of the posterior fin along the trunk is slightly longer than the posterior part along the caudal segment, the fin is broadest at the level posterior to the trunk-tail septum and is provided with a very narrow rayless zone along the trunk in front of the female genital aperture as in *pacifica*. The collarette is practically absent in all examined specimens. The eye-pigment (Figs. 6 and 10) is elongate, but relatively thicker than in *pacifica*. For instance, in a perfectly preserved mature specimens of *pacifica* from the Shellback station SB 50, length of eye-pigment/length of eye ×100 was 23.4–24.0 and width of pigment/length of pigment ×100 was 25.0–27.3, whereas the former was 27.9–34.6 (30.5 on an average of 4 measurements) and the latter was 32.6–50.0 (43.7 on an average of 4 measurements) in *tasmanica*. And this difference provides a means of separating immature specimens of *pacifica* and *tasmanica*. The ovary at maximum length reaches slightly beyond the middle of the anterior fin and contains up to 30 eggs arranged in two rows, but usually it ends near the anterior end of the posterior fin and contains less than 20 eggs. The seminal vesicle (Figs. 7–8) is situated near the rear end of the posterior fin, being fairly apart from the

9 Sag. serratodentata tasmanica (I)

No.	body length	tail seg. in %	hook	ant. teeth	post. teeth	maturity	loc
1	6.5mm.	25.0	6—7	6—6	15—16	m	SB 75
2	6.8	26.7	5—5	6—6	13–13	m	SB68
3	7.0	26.9	6—6	5—6	12–13	m.	SB71
4	7.2	23.6	5—6	6—6	13–13	med	SB 71
5	7.6	23.1	7—7	6—6	14–14	im.	SB 90
6	8.1	26.4	6—6	6—7	13–14	im.	SB95
7	8.2	23.8	6—6	5—5	11–12	m	SB 68
8	8.5	26.2	6—6	6—6	14–15	med.	SB 95
9	9.0	24.6	6—6	7—7	15–16	med.	SB100
10	9.1	25.0	5—6	7—8	16–17	im.	SB 145
11	9.2	24.6	6—6	6—6	11–12	med	SB132
12	9.3	23.1	5—5	7—7	15–16	m	SB95
13	9.4	25.5	6—6	5—6	14–15	med.	SB 85
14	9.4	24.1	6—6	6—7	16–16	m	SB112
15	9.8	23.3	6—6	7—7	14–15		SB170
16	9.8	26.7	6—6	6—7	14–15	med.	SB 85
17	9.8	25.3	6—6	5—6	13–13	m	SB 90
18	9.9	25.7	6—6	7—7	15–15	im.	SB50
19	9.9	21.1	6—6	7—7	15–16	m.	SB 85
20	9.9	23.5	6—6	7—7	15–16	m.	SB 180
21	10.1	25.6	6—6	6—7	13–14	im.	SB 90
22	10.1	23.1	6—7	7—7	13–13	med.	SB137
23	10.2	23.6	6—6	7—7	16–17	m.	SB 35
24	10.3	24.1	6—6	7—7	17–18	m.	SB 50
25	10.3	25.2	6—6	7—7	16–17	im.	SB 35
26	10.4	22.5	6—6	6—6	15–15		SB 30
27	10.5	24.8	6—6	8—8	15–17	m.	SB 35
28	10.5	23.5	6—6	7—8	19–19	m.	SB109
29	10.6	26.4	6—6	5—7	13–14	im.	SB 35
30	10.6	23.9	5—5	7—8	16–17	m.	SB 35
31	10.7	24.8	6—6	6—7	15–15	im.	SB 35
32	10.7	25.5	6—6	6—7	16–17	m.	SB 50

Table 9–1. Armature formulae of *S. serratodentata tasmanica*.
SB···Shellback Exp.

caudal fin, although in very early stages of the development (16 in Fig. 7), it may be separated considerably from both of the posterior and tail fins. It is elongate, and slightly swollen anteriorly in early stages, but becomes oval at maturity. A small prominence may be produced at maturity at the antero-lateral corner (21–26 in Fig. 7), where the glandular tissue is located, and the rupture occurs just around this prominence (27 in Fig. 7 and Fig. 8); evidently protandric. The intestinal diverticula absent. Rows of anterior teeth meet each other in an acute angle. The armature formulae of some individuals (for instance Nos. 3, 7, 11, 17, 22 and 45 in Table 9) from the Shellback area resemble those of typical *serratodentata atlantica*

9 Sag. serratodentata tasmanica (2)

No.	body length	tail seg. in %	hook	ant. teeth	post. teeth	maturity	loc.
33	10.8	21.7	5—6	6—6	12—14	m.	SB 80
34	10.8	24.1	6—6	6—7	15—15	m.	SB 35
35	10.9	25.6	6—6	7—7	15—15	m.	SB 35
36	10.9	24.0	5—5	7—7	15—17	m.	SB 115
37	11.0	24.7	6—6	7—7	15—15	im.	SB 35
38	11.1	23.5	5—6	7—7	14—14	med.	SB 130
39	11.1	22.4	7—7	7—7	14—15		SB 1
40	11.2	24.4	5—5	7—8	16—17	m.	SB 105
41	11.4	21.7	5—5	6—7	17—18	m.	SB 137
42	11.4	22.9	6—6	7—7	14—14	med.	SB 137
43	11.7	25.0	6—6	7—7	14—16	med.	SB 35
44	11.8	23.1	6—6	7—7	16—16	m.	SB 137
45	12.0	24.3	6—7	6—7	13—13	im.	SB 132
46	12.1	23.7	7—7	5—5	13—15	m.	SB 137
47	12.2	25.1	6—6	7—8	18—18	med.	SB 105
48	12.2	25.1	6—6	8—8	17—17	med.	SB 112
49	12.2	25.1	6—7	7—7	14—14	med.	SB 132
50	12.2	23.7	5—5	7—7	21—21	m.	SB 137
51	12.4	23.7	5—5	4+*—7	15—15	m.	SB 118
52	12.5	21.9	5—6	10—10	22—22	m.	SB 137
53	12.6	23.7	6—6	6—7	16—17	med.	SB 115
54	12.7	24.1	6—6	5—6	16—16	med.	SB 115
55	12.7	23.1	6—6	7—8	17—18	im.	SB 137
56	12.7	24.1	7—7	6—7	15—15	m.	SB 1
57	13.0	23.0	5—5	7—7	15—16	m.	SB 109
58	13.1	22.3	6—6	7—7	16—17	m.	SB 118
59	13.2	23.6	6—6	5—6	13—14	m.	SB 1
60	13.3	23.9	5—5	8—8	20—21	med.	SB 112
61	14.3	22.8	6—6	8—8	17—18	m.	SB 122
62	14.7	23.5	6—6	8—8	15—15	med.	SB 122
63	15.0	21.7	5—5	7—7	16—17	m.	SB 132

Table 9–2. Armature formulae of *S. serratodentata tasmanica*.
* Some torn out. SB···Shellback Exp.

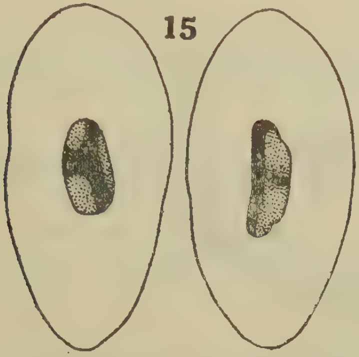

Fig. 6. *Sagitta serratodentata tasmanica* THOMSON. Eyes of a 10.3 and 10.7 mm long individuals, magnified.

10 Sag. serratodentata pacifica

No	body length	tail seg. in %	hook	ant teeth	post. teeth	maturity	loc.
1	8.4mm	26.4	7—7	6—6	13—13	m.	SB50
2	8.5	27.7	6—6	7—7	13—13	m.	SB50
3	8.6	26.3	7—7	7—7	12—12	m.	SB50
4	9.0	23.9	6—6	10—11	19—21	med.	SB 64
5	9.4	24.1	7—7	10—10	18—18	med.	SB 90
6	9.9	25.0	6—6	8—9	15—18	med.	SB90
7	10.1	25.8	6—6	10—11	19-20	m.	SB35
8	10.4	26.3	6—7	9—9	18—19	im.	SB35
9	10.6	25.2	6—6	9—10	20-21	m.	SB 35
10	10.9	25.6	5—6	9-10	21—22	m.	SB35
11	11.0	25.4	6—7	8—9	20-20	m.	SB 35
12	11.1	23.5	5—6	11—11	22-23	m.	TP
13	11.2	26.0	6—6	11—11	21—21	m.	SB35
14	11.4	26.1	6—6	10—10	18—18	m.	SB105

11 Sag. serratodentata pseudoserratodentata

No.	body length	tail seg. in %	hook	ant. teeth	post. teeth	maturity	loc
1	7.0mm	28.0	6—6	4—4	9—12	m.	SB 215
2	7.6	27.4	6—6	5—5	11—11	m.	SB215
3	7.6	27.4	6—6	6—6	13—13	m.	SB 215
4	7.7	28.0	6—6	6—6	12—13	m.	SB215
5	7.7	28.0	6—6	5—6	12—12	m.	SB215
6	8.2	27.8	6—7	7—7	14—14	med.	SB 80
7	9.8	25.3	6—6	7—7	13—13	im.	SB 50
8	9.8	24.0	6—6	6—7	12—13	im.	SB50
9	10.8	26.5	6—6	6—7	14—14	im.	SB50

Tables 10–11. Armature formulae of *S. serratodentata pacifica* (10) and *S. serratodentata pseudoserratodentata* (11). SB···Shellback Exp.

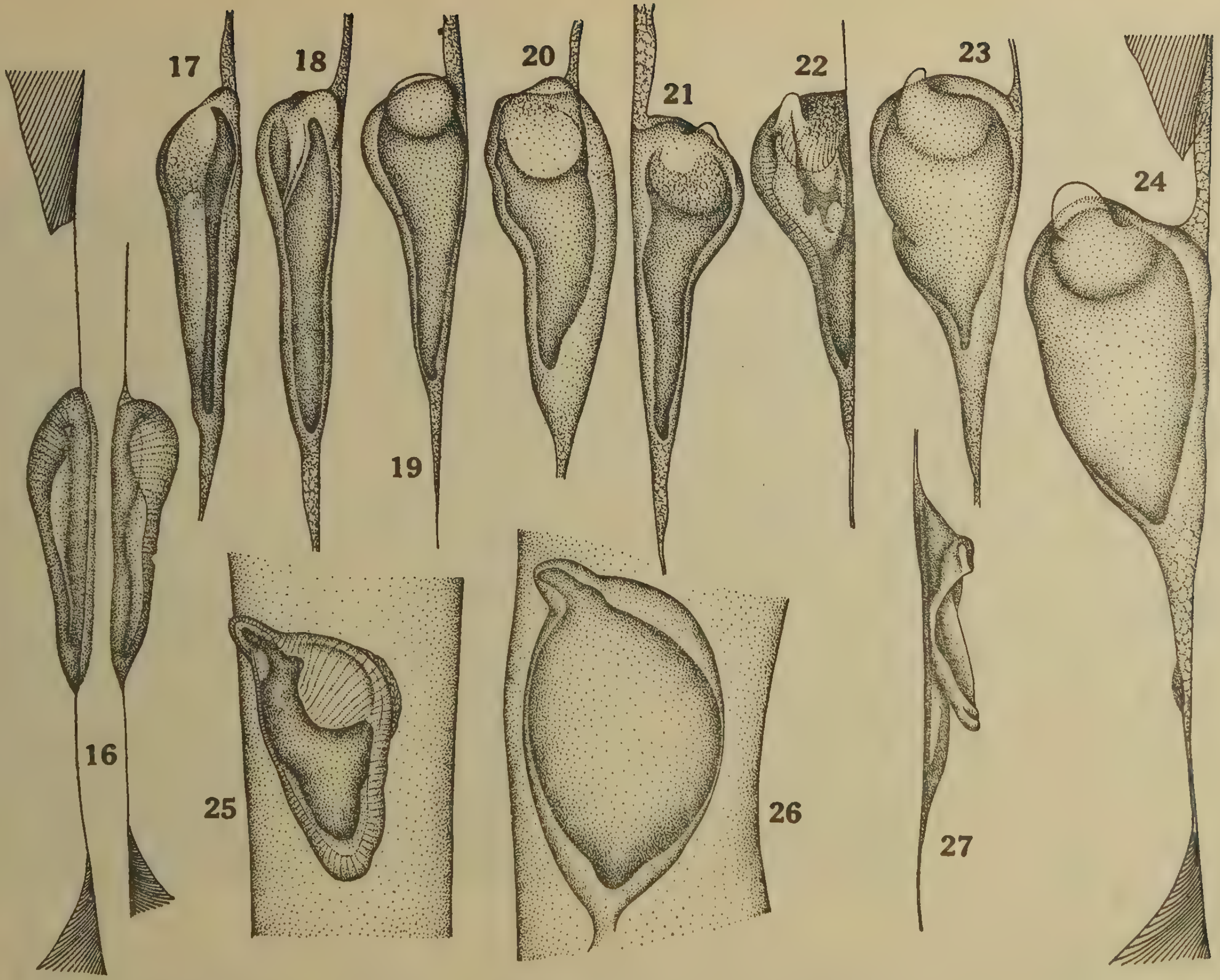

Fig. 7. *Sagitta serratodentata tasmanica* Thomson. Seminal vesicles of various stages of development, arranged in the order of maturity, ×125. 16—SB 132, 20—dorsal; 21, 22—SB 137; 23, 24—dorsal; 25, 26—right vesicles, SB 137; 27—ruptured.

and those of some others (for instance Nos. 28, 47, 50, 52 and 60 in the same table) are related closely to those of typical *pacifica*. Since some of these unusual specimens are provided with seminal vesicles of the typical *tasmanica*-form, it is unlikely that some specimens of *atlantica* and *pacifica* were mistaken for *tasmanica*. The number of posterior teeth is most frequently 13–17 (Fig. 9) and this is evidently an intermediate between those of *atlantica* and *pacifica*.

Remarks: For comparison with the present subspecies, some specimens of *pacifica* and *pseudoserratodentata* from the Shellback area were examined closely. In *pacifica*,

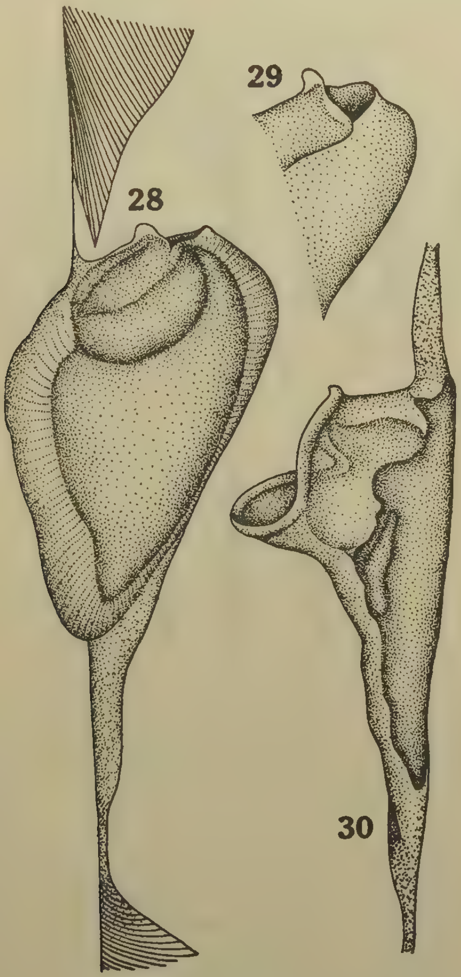

Fig. 8. *Sagitta serratodentata tasmanica* THOMSON. Seminal vesicles of a 14 mm long individual $\left(\text{tail seg. } 24.7\%,\ 6\text{–}6\ \frac{7\text{–}8}{18\text{–}18}\right)$, ×125. 28—left vesicle, just rupturing; 29—ruptured portion; 30—right vesicle, fully ruptured.

the collarette is usually distinct, though not voluminous. The ovary may reach anteriorly to about the ventral ganglion and contains up to 40 eggs at maximum. There are very many individuals in which the seminal vesicles projected out obliquely anteriorly. The armature formulae of 14 specimens with mature seminal vesicles are given in Table 10. In this table, the occurrence of three specimens at SB 50 with exceptionally few teeth (Nos. 1–3) is noteworthy. The teeth are so few that at first these three specimens were mistaken for *atlantica*. The structure of the seminal vesicle is, however, of the typical *pacifica*-form as shown in the figure (Fig. 10). Specimens Nos. 4 and 12 are striking in that the seminal vesicles have no teeth ; very probably they are mal-formed individuals of *pacifica*, because the cephalic teeth are numerous enough for *pacifica* and the vesicles are projected out just as in typical *pacifica*. Some authors doubt the validity of *pseudoserratodentata*. Indeed, the armature formulae of this form conforms well to those of *atlantica*. But the shape of the mature seminal vesicle (Fig. 11) is quite different between the two, also the body length of mature specimens is considerably less in *pseudoserratodentata* than in *atlantica*. In the Shellback specimens, the ovaries reach neach the middle of the anterior fin and contain up to 20 eggs in each at maturity. The serration of

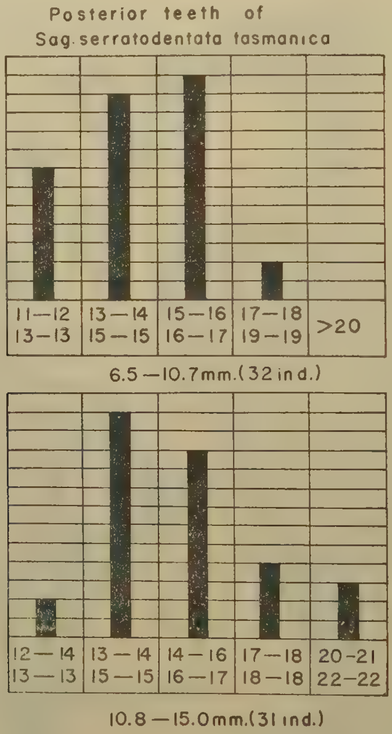

Fig. 9. *Sagitta serratodentata tasmanica* THOMSON. Fluctuation of the number of posterior teeth of specimens from the Shellback area.

hooks in *pseudoserratoddntata* is the least conspicuous of the three forms. A specimen from SB 130 has seminal vesicles which have each two prominences at the anterior end (Fig. 12) and hence at first this was considered to be *atlantica*, but the situation and the shape of the prominences differ slightly from those of typical *atlantica*, in which they are situated at the antero-lateral corner; rather the situation resembles that of a prominence of the seminal vesicle in *tasmanica*. Thus, it is possible that this specimen represents an unusual individual of *tasmanica*.

Sagitta selkirki FAGETTI from Chilean waters around the Juan Fernandez Archipelago resembles most closely *tasmanica* in the appearance of the seminal vesicle, but the constant occurrence of seven hooks and fewer posterior teeth, besides the comparatively small body length of mature individuals, seem to be unique for this form. On the other hand, the dental formulae, which are related closely with those of *selkirki* as given by FAGETTI, can be seen at some places of Table 9 to show the armature formulae of *tasmanica* from the Shellback area. So, it is not impossible that *selkirki* represents a peculiar stock of *tasmanica* as do three specimens of *pacifica* from SB 50 (p. 370). Therefore, I hesitate to judge conclusively the validity of this species at present. Lastly, here arises a question as to whether the forms,

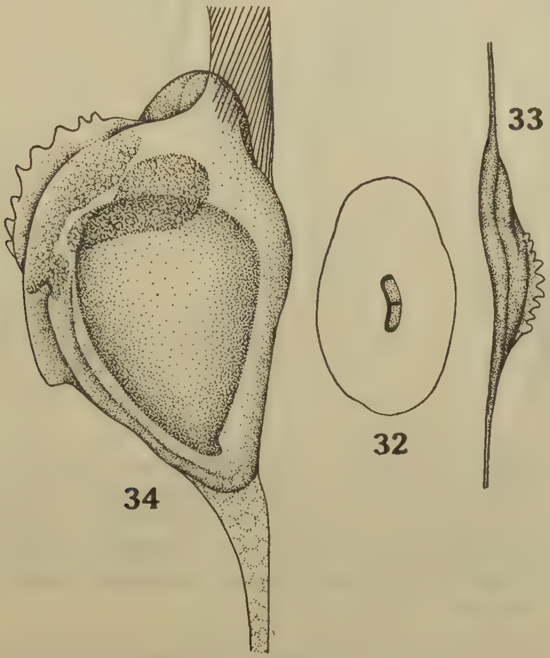

Fig. 10. *Sagitta serratodentata pacifica* TOKIOKA. A 8.5 mm long individual (No. 2 of the Table) from SB 50. 32—eye, magnified; 34—left vesicle, ×125; 33—immature right vesicle of a specimen from SB 30. ×125.

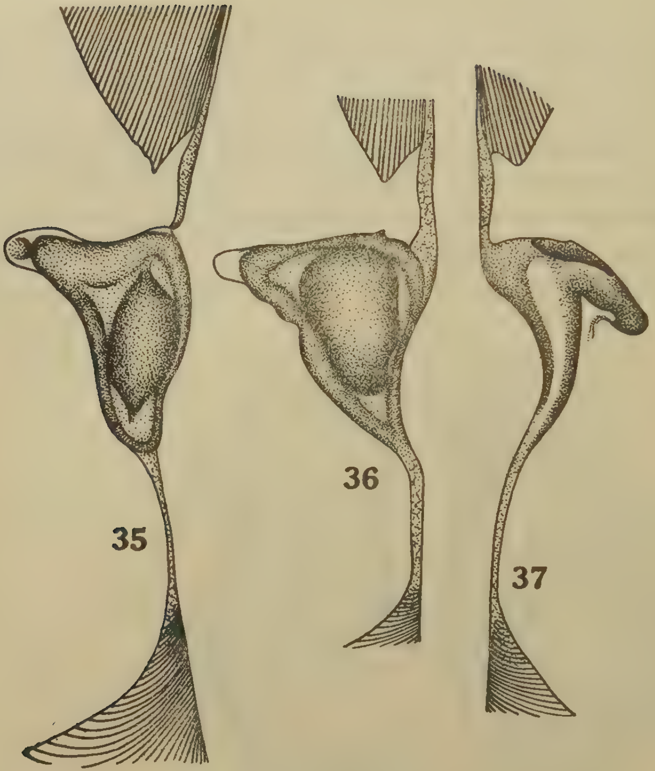

Fig. 11.

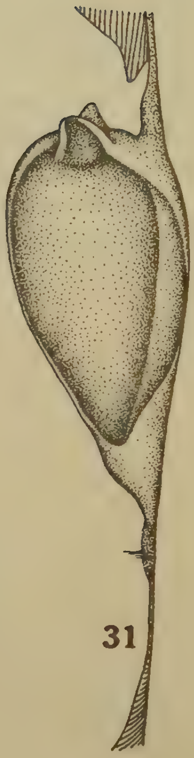

Fig. 12.

Fig. 11. *Sagitta serratodentata pseudoserratodentata* Tokioka. Seminal vesicles, ×125. 35—7.7 mm long individual from SB 215, 36—right vesicle of a 7.6 mm long individual from SB 215, 37—ruptured left vesicle of the same specimen.

Fig. 12. ?*Sagitta serratodentata atlantica*. Left seminal vesicle of a specimen from SB 130. ×125.

atlantica, *pacifica*, *tasmanica* and *pseudoserratodentata* should be ranked as species or subspecies. Since there are several distinct and important characteristics common to all of these forms, the serrated hooks, the remarkably elongate eye-pigment, the situation of seminal vesicles and the existence of a conspicuous swelling at the middle of the vas deferens besides the absence of intestinal diverticula and the general structure of the fins, the relation between these forms seems to be much closer than that found between other species. Hence, I am inclined to treat the forms as subspecies of a single species *Sagitta serratodentata*, though in some parts of this paper, especially in tables, I listed them as species in order to conserve space.

4. *Sagitta neglecta* Aida and its allies

(Figs. 13–16, Tables 12–15)

(1) *Sagitta neglecta* AIDA (Fig. 13, Table 12): This species is extremely rare in the eastern Pacific as noted already by BIERI (1959) and SUND (1959b), though it occurs rather commonly in the western part of the North Pacific. Thus, it seems necessary to compare the specimens from both sides of the North Pacific and to ascertain the identity of the eastern specimens with the western. The armature formulae of the Shellback specimens given in Table 12 conform well to those of typical forms from the western Pacific. The general structure of the body agrees closely in these two groups of specimens. For these reasons, *S. neglecta* undoubtedly occur also in the Shellback area. In specimens examined from this area, the ovary may reach to the anterior end of the ventral ganglion. Individual No. 18 in Table 12 (Fig. 13) is very peculiar in that the posterior teeth are much fewer and the

12 Sagitta neglecta

No.	body length	tail seg. in %	hook	ant. teeth	post. teeth	maturity	loc.
1	4.6mm	29.6	8—8	5—5	11—11	im.	SB60
2	4.8	29.7	7—8	5—6	12—13	im.	SB55
3	5.6	31.4	7—7	5—6	14—15	im.	SB55
4	5.9	30.0	7—7	5—6	13—14	im.	SB55
5	6.0	31.5	8—8	6—6	13—14	im.	SB80
6	6.0	29.0	8—8	5—5	14—15	im.	SB170
7	6.2	30.2	7—7	6—7	15—15	im.	SB55
8	6.2	34.4	7—7	6—7	15—16	im.	SB60
9	6.5	34.0	6—7	7—7	16—17	im.	SB60
10	6.5	33.0	7—7	6—6	14—14	med.	SB60
11	6.8	33.3	7—8	6—7	16—16		SB170
12	6.8	31.4	7—7	5—6	13—13	m.	SB195
13	6.9	30.2	8—8	6—6	17—18	im.	SB60
14	6.9	28.3	7—8	6—7	16—16		SB170
15	7.2	30.9	7—8	2+*—7	17—17	m.	SB109
16	7.3	32.1	6—6	6—6	17—17	m.	SB68
17	7.5	32.2	8—8	4+*—6	16—17	m.	SB68
*18	7.5	28.7	0+*—3+*	5—6	7—10	med.	SB50
19	7.7	29.4	7—7	7—7	17—17		SB170
20	8.1	28.0	7—8	7—8	18—18	m.	SB170

13 Sagitta oceania

No.	body length	tail seg. in %	hook	ant. teeth	post. teeth	maturity	loc.
1	4.3mm	31.8	7—7	4—5	11—12	m.	EQPS28
2	4.7	31.5	7—8	5—5	13—13	m.	EQPS28
3	4.8	32.4	7—7	4—5	12—12	m.	EQPS28

Tables 12–13. Armature formulae of *S. neglecta* (12) and *S. oceania* (13).
* Some torn out. SB···Shellback Exp.

intestinal diverticula are not distinct. The anterior fin begins at the posterior end of the ventral ganglion, the posterior fin is slightly longer than the anterior, equally divided on the trunk and the caudal segment and broadest at the level posterior to the trunk-tail septum; the constriction of the body at this septum is not remarkable. Rayless zones were not found on either fin. A thin collarette is present around the neck. The ovary at medium maturity reaches to the front end of the posterior fin. The seminal vesicle (39) is situated near the rear end of the posterior fin; its shape resembles that of *Sagitta oceania*. Eye-pigment (38) oval, length of pigment/length of eye ×100 is 39.4–43.8, width of pigment/length of pigment ×100 is 53.8–60.7. The fewer number of hooks is evidently attributable to some injury. The armature formula, the situation of the seminal vesicle, and the indistinctness of the intestinal diverticula suggest a possible identity of this specimen with *Sagitta setosa* from the European waters. However, since the shape of the corona ciliata was not ascertained, and the anterior fin seems too long for *setosa* and moreover the locality is so far

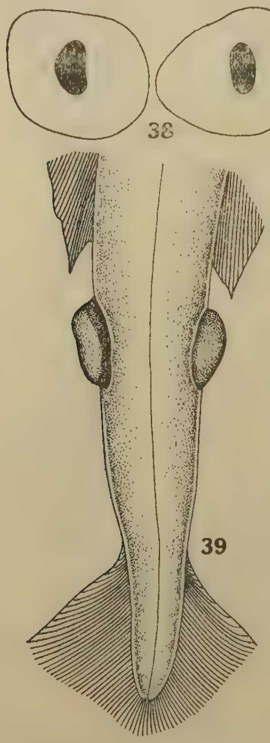

Fig. 13. A problematic specimen (No. 18 of the Table), treated here provisionally as *Sagitta neglecta* AIDA, from SB 50. 38—eyes, magnified; 39—seminal vesicles, dorsal. ×73.

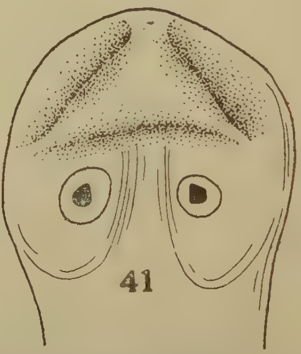

Fig. 14. *Sagitta oceania* GRAY. Head of a 4.3 mm long individual from EQP S-28. ×125.

removed from the European waters, one hesitates to treat the specimen as *setosa.* Rather, it is treated here provisionally as an unusual individual of *neglecta* pending further detail study of specimens in better state of preservation.

(2) *Sagitta oceania* GRAY (Figs. 14–15, Table 13): Six specimens up to 4.8 mm were found in the sample from EQP–S 28. The anterior fin begins at the posterior end of the ventral ganglion; the posterior fin is longer than the anterior, nearly equally divided on the trunk and the tail segment and broadest at the level posterior to the trunk-tail septum. Rayless zone absent in both fins, although rays are very sparse in a small part near the frontal end. The collarette is practically absent, eye-pigment (41) is roundish and very large. The ovary reaches slightly beyond the posterior end of the anterior fin, eggs are unequal in size. The seminal vesicles are situated nearer the posterior fin than the caudal fin; distance to posterior fin/distance to caudal fin is 0.32 to 0.70, being 0.48 on an average of 4 measurements. The distinction between *neglecta* and *oceania* is rather exacting as mentioned already in detail when *Sagitta lacunae* was described from the lagoon water of the Palao Islands (TOKIOKA, 1942). The absence of the collarette and the large eye-pigment in the present specimens seem to refer them to *oceania* rather than *neglecta.* However, it is noteworthy that these specimens have attained maturity at such a small body size.

(3) *Sagitta regularis* AIDA (Table 14): The armature formulae of the Shellback-specimens are closely related to those of the Eastropic Expedition specimens as given by SUND (1959b). This species seems to mature much more rapidly in the Shellback area than in the western part of the North Pacific, as indicated in individuals only 4 mm long having 5–8 mature oval eggs arranged in zigzag rows and in a 4.6 mm specimen in which the ovary reached to the ventral ganglion. The formulae of some small individuals resemble closely those of *Sagitta bedfordii*, but the apparent shape of the eye-pigment differs distinctly between *regularis* and *bedfordii*; it is roundish in the latter, while it is distinctly elongate in the former.

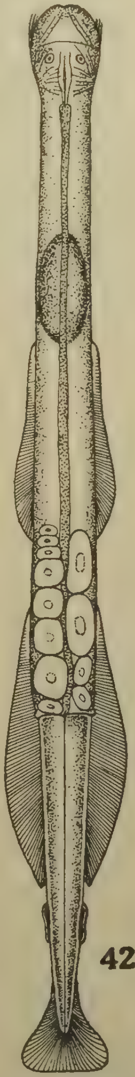

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Fig. 15. *Sagitta oceania* GRAY. A 4.8 mm long individual from EQP S-28.

14 Sagitta regularis

No.	body length	tailseg. in %	hook	ant. teeth	post. teeth	maturity	loc.
1	3.3mm	37.3	10—10	2—2	2—3	im.	SB35
2	3.9	30.0	7—7	2—2	2—2	im.	SB75
3	4.0	35.5	8—9	3—3	4—4	m.	SB30
4	4.0	32.8	8—8	2—2	3—3	m.	SB30
5	4.5	33.3	8—8	3—3	5—5	m.	SB30
6	4.6	34.3	6—7	3—3	4—4	m.	SB80
7	4.6	31.4	7—8	3—?	3—4		SB40
8	4.9	36.0	7—7	2—3	5—5	m.	SB35
9	4.9	33.3	7—7	4—4	4—4		SB35
10	5.0	32.5	8—8	4—4	6—6	im.	SB100
11	5.1	34.2	7—8	3—4	6—6	m.	SB35
12	5.1	33.3	8—8	3—3	4—4	m.	SB30
13	5.2	34.0	7—7	3—4	5—6	med.	SB35
14	5.2	33.8	6—6	3—3	5—5	med.	SB35
15	5.2	33.8	8—8	3—4	4—5		SB35
16	5.2	33.8	7—7	3—3	3—3	med.	SB35
17	6.9	32.0	8—8	3—3	4—5	m.	SB112

Table 14. Armature formulae of *S. regularis*.
SB···Shallback Exp.

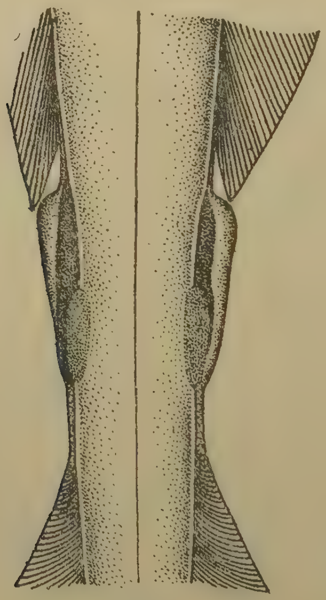

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Fig. 16. *Sagitta crassa* f. *naikaiensis* Tokioka. A 6 mm long individual from the offshore waters of North Eastern Honsyû, Japan. Seminal vesicles. ×125

15 Sagitta crassa f. naikaiensis

No.	body length	tail seg. in %	hook	ant. teeth	post. teeth	maturity	JAPAN
1	4.0 mm	30.6	9—9	2—2	2—3	im.	off the north eastern Honsyu
2	4.0	29.0	7—9	4—4	6—6	im.	
3	4.9	29.3	8—8	4—4	7—7	im.	
4	5.4	27.7	8—9	4—5	7—8	im.	
5	5.5	29.8	7—8	4—5	8—8	med.	
6	6.0	30.4	9—9	5—5	9—9	m.	

Table 15. Armature formulae of *S. crassa* f. *naikaiensis.*

(4) ***Sagitta crassa*** f. ***naikaiensis*** TOKIOKA (Fig. 16, Table 15): To ascertain the identification of the specimens from the offshore waters off North-Eastern Honsyû, Japan, some individuals were dissected. The distinct collarette around the neck, the corona ciliata beginning at the level posterior to eyes, the large eye-pigment and the distinct but rather small intestinal diverticula together with the shape and situation of the seminal vesicles (Fig. 16) seem to ascertain the identity of these specimens with ***crassa*** f. ***naikaiensis.*** The ovary is limited to a range posterior to the frontal end of the posterior fin.

5. *Sagitta neodecipiens* n. sp.

(Figs. 17–20, Tables 16–17)

Length up to 13.2 mm in examined specimens. The tail segment occupies most frequently 28–29% of the whole body length. General appearance of the body (Fig. 17) resembles closely that of *S.* ***decipiens.*** The anterior fin begins at the posterior end of the ventral ganglion. The posterior fin is nearly as long as or very slightly shorter than the anterior and divided approximately equally on the trunk and the caudal segment, although sometimes the anterior half along the trunk is slightly longer than the posterior half along the tail segment; it is widest near the trunk-tail septum. In both fins, the thin anterior terminal portion is devoid of fin rays; and in the posterior fin, there is a narrow rayless-zone along the trunk anterior to the female genital opening. The collarette is indiscernible in any of the examined specimens; no constriction at the trunk-tail septum. The eye-pigment (Fig. 18) is rather small, elongate and somewhat resembles that of *S.* ***bipunctata*** rather than that of *S.* ***decipiens.*** The pigment is not dense as in ***decipiens,*** but somewhat shorter than in ***decipiens.*** Length of pigment/length of eye ×100 is 28.6 to 44.1, being 40.2 on an average of seven measurements, and width of pigment/length of pigment × 100 is 31.8 to 50.0 and 39.2 on an average of seven measurements. In ***decipiens,*** length of pigment/length of eye ×100 is 49.3 to 61.2 in three measurements and 55.7 on an average, and width of pigment/length of pigment ×100 is 23.1 to 39.7 and 29.9 on an average. Thus, generally speaking, the pigment seems shorter, but

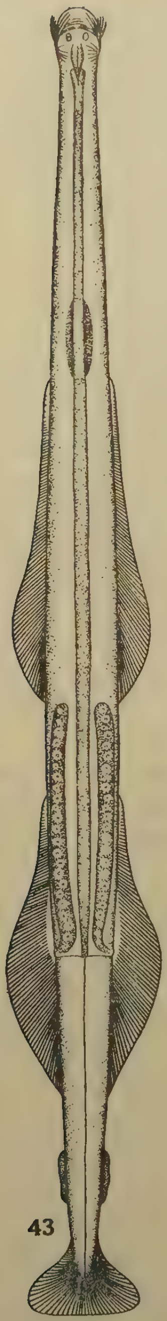

Fig. 17. *Sagitta neodecipiens* n. sp. A specimen from SB 1, dorsal.

relatively thicker than in *decipiens*. It is also shorter than that of *S. serratodentata tasmanica*. The armature formulae resembles closely those of *decipiens* as shown in Tables 16 and 17. Hooks are most frequently 6, not serrated; the anterior teeth (Fig. 19) are very short and triangular as in *decipiens* and rows meet each other usually in right or obtuse angles. The ovary at maximum length reaches anteriorly to the posterior end of the anterior fin in examined specimens. The seminal vesicles (Fig. 20) are situated approximately at the middle of the distance between the posterior and caudal fins. They are elongate and provided with a glandular portion at the anterior end. The rupture occurs along the whole lateral side at maturity. The intestinal diverticula are present as in *decipiens*.

Remarks: The present species resembles so closely *S. decipiens* that it is hardly possible to separate distinctly immature specimens of these two forms not yet having any trace of the seminal vesicles. The only apparent distinction lies in the situation of these vesicles. The difference found in size of the eye-pigment is too exacting to be practicable as a clue to differentiating these forms. In *decipiens*, the vesicles are situated near the base of the caudal fin, being far apart from the posterior fin; distance between the posterior fin and the vesicle/distance between the vesicle and the caudal fin is 4.83 to 8.75 and 7.21 on an average of four measurements. While in the present form, the ratio is 0.29 to 2.08 and 1.12 on an average of 33 measurements. However, the original description of *Sagitta decipiens* was made by FOWLER (1905) on specimens without seminal vesicles, consequently it is impossible to determine definitely whether the present form is identical with FOWLER's original specimens or not. But in order to prevent confusion, it seems reasonable to recognize the forms described by RITTER-ZÁHONY (1911) as being identical with FOWLER's specimens. Then the present specimens are separable distinctly from *decipiens* described by

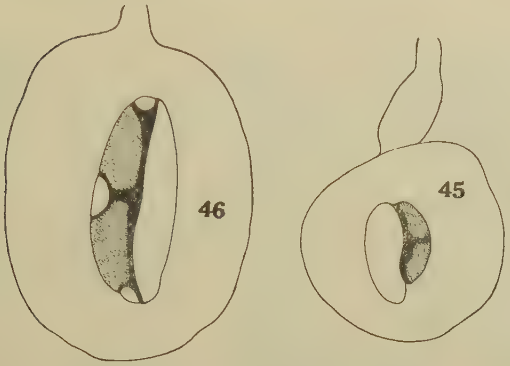

Fig. 18. Eyes of 45—*Sagitta neodecipiens* n. sp. from SB 181 and 46—*Sagitta decipiens* Fowler from SB 181, magnified.

16 Sagitta neodecipiens

No	body length	tail seg. in %	hook	ant. teeth	post. teeth	maturity	loc.
1	7.3mm	31.0	6—6	8—8	15—16	med.	SB112
2	7.4	29.8	6—6	7—7	15—15	im.	SB112
3	7.8	31.7	6—6	8—8	17—17	med.	SB112
4	8.1	28.0	6—6	7—7	15—15	med.	SB112
5	8.1	28.0	6—7	6—6	13—13	im.	SB122
6	8.1	28.0	6—6	7—8	12—14	med.	SB215
7	8.5	30.7	7—7	7—7	14—14	med.	SB145
8	8.7	28.4	6—6	8—8	14—14	med.	SB122
9	8.9	29.2	6—6	8—8	16—16	med.	SB122
10	9.0	29.7	6—6	10—10	17—18	m.	SB181
11	9.4	30.0	6—6	7—8	14—14	m.	SB150
12	9.6	29.7	6—6	9—9	19—19	m	SB122
13	10.4	31.3	6—6	9—10	17—18	im.	SB 1
14	10.5	28.6	6—6	8—9	18—18	im.	SB50
15	10.8	29.6	6—6	9—10	17—17	im.	SB50
16	10.9	28.6	6—6	7—7	13—14	im.	SB 1
17	11.1	26.3	6—6	8—9	15—16		SB 1
18	11.1	29.4	6—6	9—9	16—17	im.	SB50
19	11.1	28.7	6—6	8—8	15—16	im.	SB50
20	11.2	29.1	6—6	6—9	17—17	im.	SB 1
21	11.2	27.7	6—6	8—9	16—18	med.	SB 1
22	11.4	29.7	6—6	9—10	18—19	im.	SB50
23	11.8	28.2	6—6	9—9	15—16	med.	SB 1
24	12.1	27.4	6—6	9—9	16—17	im.	SB 1
25	12.7	28.2	6—6	8—8	15—16	med.	SB 1
26	13.2	28.6	6—6	9—9	16—16	med.	SB 1

Table 16. Armature formulae of *S. neodecipiens.*
SB···Shellback Exp.

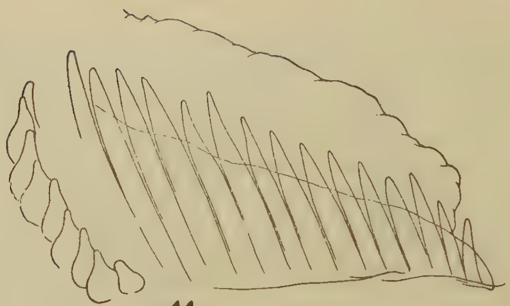

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Fig. 19. *Sagitta neodecipiens* n. sp. Anterior and posterior teeth of an individual from SB 1, magnified.

17 Sagitta decipiens

No	body length	tail seg. in %	hook	ant teeth	post. teeth	maturity	loc
1	3.6mm	32.7	7—7	4—4	6—6	im.	EQPS28
2	5.5	29.4	7—7	7—7	11—13	im.	EQPH17
3	6.2	25.0	7—7	5—5	10—10	im	EQPH 17
4	6.2	29 5	7—8	6—6	11—11	im.	EQPH17
5	7.5	28.7	6—7	7—8	13—14	im.	SB122
6	8.8	27.4	6—7	8—8	14—14	im.	SB122
7	8.9	27.0	6—6	8—8	14—16	m.	SB90
8	8.9	27 7	7—7	9—9	15—16	m	SB100
9	9.0	28.1	6—6	8—9	17—18	im.	SB 85
10	9.1	25.0	6—6	8—8	14—15	m	SB180
11	9.4	27.6	6—6	9—9	16—17	im.	SB50
12	9.4	27 6	5—6	9—10	17—18		SB 30
13	9.6	25.7	6—6	8—8	17—17	med.	SB 75
14	9.6	25.2	6—6	9—9	18—20	med.	SB50
15	9.6	27.2	6—6	9—10	18—19	m	SB50
16	10.1	27.1	6—6	9—9	17—18	m	SB85
17	10.6	26.4	6—6	9—10	17—17	med.	SB50
18	10.7	27.4	5—6	10—10	20—20		SB30
19	10.7	29.1	5—6	9—9	16—17	med.	SB 1
20	10.7	27.4	6—6	9—10	18—19	m.	SB50
21	10.7	26.8	6—6	9—9	19—20	med	SB50
22	10.7	27.3	6—6	9—9	15—17	med.	SB85
23	10.7	22.4	6—6	8—8	16—17	m.	SB195
24	11.2	25.0	6—6	7—7	14—15	m	SB 1
25	11.4	28.4	6—6	7—8	15—15	med.	SB 1
26	13.2	24.6	6—7	7—8	19—19	med.	SB181
27			7—7	7—7	14—15	med.	EQPH11

Table 17. Armature formulae of *S. decipiens*.
SB···Shellback Exp.

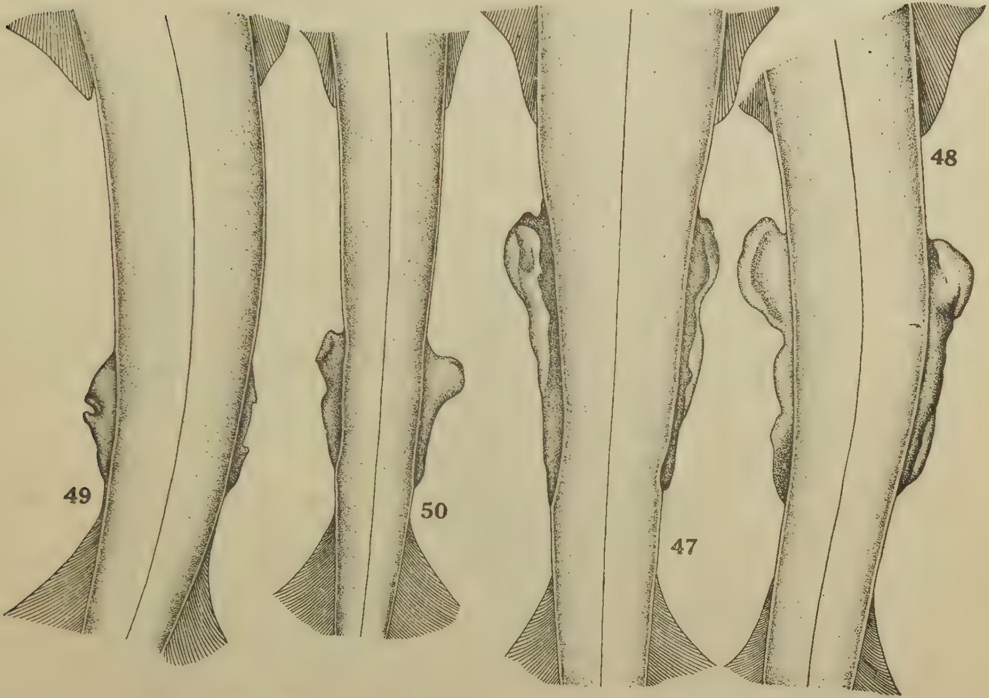

Fig. 20. Seminal vesicles of 47, 48—*Sagitta neodecipiens* n. sp. from SB 50, respectively 11.1 and 10.8 mm in length, and 49, 50—*Sagitta decipiens* FOWLER respectively from SB 181 and SB 195 (10.7 mm in length).

RITTER-ZÁHONY by the situation of the seminal vesicles. So I think it best to treat the present form as a separate species differentiated from *decipiens* and named "*neodecipiens*" because of its close resemblance to *decipiens.*

6. *Sagitta bedoti* BÉRANECK f. *minor* TOKIOKA

(Table 18)

The specimens occurring in the Shellback area are all small, less than 13.3 mm in length and the ovary at its maximum length reaches to the posterior end of the anterior fin. The anterior end of the intestine may be slightly swollen and becomes whitish and opaque in some specimens. These features together with the armature formulae seem to assign the Shellback specimens to f. *minor* found abundantly in the tropical waters in the western Pacific. Specimens from the Eastropic Expedition resemble wholly the Shellback individuals (SUND, 1959b). The distance between eyes is comparatively large, distance between eyes/width of head is 34.3–40.0 in examined specimens.

18 Sagitta bedoti f. minor

No	body length	tail seg. in %	hook	ant. teeth	post. teeth	maturity	loc.
1	5.9 mm	22.2	6—7	6—?	20–20	im.	SB 75
2	6.1	25.5	7—7	8—8	17–18	im.	SB 60
3	7.2	27.3	7—7	6—7	20–20	im.	SB 95
4	7.3	26.5	6—7	9—9	23–23	im.	SB 60
5	7.8	25.0	7—7	10—10	20–21	im.	SB 55
6	7.9	25.4	8—8	10—10	25–27	im.	SB 55
7	7.9	24.6	7—7	10—10	24–25	im.	SB 64
8	8.2	25.4	7—7	7—8	20–20	im.	SB 100
9	8.4	24.8	7—7	10—10	24–24	im.	SB 75
10	8.6	24.8	6—7	9—11	29–30	im.	SB 60
11	8.7	28.4	7—7	9—9	23–24	med.	SB 90
12	9.1	28.6	7—7	9—9	24–24	med.	SB 105
13	9.2	26.1	6—7	10—10	29–30	med.	SB 55
14	9.2	25.4	6—6	11—11	28–30	im.	SB 60
15	9.3	26.5	7—7	10—11	25–26	im.	SB 55
16	9.5	24.7	7—7	9—10	22–22	med.	SB 80
17	9.8	26.0	7—7	11—11	22–24	med.	SB 80
18	9.8	22.7	8—8	9—10	25–26	im.	SB 155
19	10.1	23.2	7—7	12—12	26–26	med.	SB 64
20	10.3	24.8	7—7	12—12	26–27		SB 166
21	10.4	24.7	7—7	10—10	27–27		SB 166
22	10.4	23.8	8—8	10—10	22–22	med.	SB 105
23	10.6	24.5	7—7	10—10	24–25	med.	SB 68
24	10.9	25.0	7—7	8—9	24–24	med.	SB 155
25	10.9	24.0	6—8	12—12	29–30	im.	SB 71
26	11.1	23.5	7—7	10—10	25–26	im.	SB 68
27	12.0	24.3	7—8	11—11	24–27	med.	SB 68
28	12.0	23.9	7—7	11—11	29–29	med.	SB 68
29	12.1	23.7	7—7	11—11	29–29	im.	SB 155
30	13.3	24.4	7—7	10—10	26–28	m.	SB 109
31	13.3	26.3	7—7	10—11	26–26	m.	SB 109

Table 18. Armature formulae of *S. bedoti*.
SB···Shellback Exp.

7. *Sagitta hexaptera* D'ORBIGNY

(Fig. 21)

Many large specimens, 40–50 mm in length, were collected from the Shellback area, the largest of all was the 58 mm long individual from SB 195. These seem to be slightly larger than the Eastropic specimens (SUND, 1959b). As there are some specimens in which the seminal vesicles are quite mature and preserved perfectly, a typical one is shown here in Fig. 21. The situation of the vesicle varies considerably,

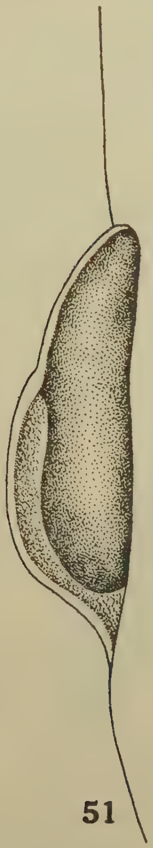
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Fig. 21. *Sagitta hexaptera* D'ORBIGNY. Seminal vesicle of an individual from MP 16. ×125.

although it is nearer the caudal fin than the posterior fin; distance between posterior fin and vesicle/distance between vesicle and caudal fin is 4.33 to 6.64, being 5.25 on an average of 5 measurements. The shape is elongate and slightly swollen in the posterior half, where the glandular tissue is found.

8. *Sagitta enflata* f. *gardineri* DONCASTER

(Table 19)

Sagitta gardineri...DONCASTER (1903): Chaetognatha, with a note on the variation and distribution of the group. The fauna and geography of the Maldive and Laccadive Archipelagoes, Vol. I.

Sagitta inflata, *gardineri*-Typus...RITTER-ZÁHONY (1909): Denkschriften der Mathematisch-Naturwissenschaftlichen Klasse der Kaiserlichen Akademie der Wissenschaften Wien, Bd. LXXXIV, pp. 5-7.

There were found many large individuals of *S. enflata* in the Shellback area, especially at Stations SB 112 and SB 122. They attain 27 mm in body length; the ovary is long, generally reaching to the middle of the anterior fin at maturity and contains up to one hundred or more eggs in one organ; it may reach even to the frontal end of the anterior fin (No. 5 in the Table). Contrarily, the ordinary small forms (*minor*-Typus by Ritter-Záhony) have much shorter ovaries that are limited within the area posterior to the frontal end of the posterior fin and containing up to 30 eggs. Fagetti (1958a) also found such larger individuals with longer ovaries in the waters off Central–Northern Chile. She notes that the larger specimens are provided with more teeth than the smaller ones and this is true also in the Shellback individuals. However, it is rather a general feature that the teeth increase with body length. The armature formulae of both forms from the Shellback area seem to be continuous as shown in the table. Ten anterior teeth are recorded also on some larger individuals of the small form as indicated by Sund (1959b) on a 11.8 mm long specimen from the Eastropic Expedition and on 15.4–15.6 mm long specimens which were collected by Hida in the middle part of the North Pacific. For these reasons, I hesitate to consider the number of teeth as a significant characteristic. At any rate, these large forms with longer ovaries can be safely identified as *Sagitta enflata* f. *gardineri*, first described by Doncaster (1903) from the waters around the Maldive and Laccadive Islands and later reported by Ritter-Záhony (1909) from the Red Sea. It is not yet known from the Mediterranean Sea (Ghirardelli 1951, Massuti 1958). As it is hardly possible to distinguish young individuals of this form from those of the ordinary type, the exact range of distribution is not yet fully known. If the occurrence of this form is confined to some special water masses or if it is ascertained that there is no intermediate state between the longer and

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No	body length	tailseg. in %	hook	ant. teeth	post. teeth	maturity	loc.
Sagitta enflata ordinary form							
1	12.7mm	19.0	9—10	7—8	12—13	m.	SB112
2	13.2	19.0	9—9	7—8	11—12	m.	
3	13.7	19.0	10—10	7—8	12—13	m.	
4	17.2	17.0	10—10	8—8	14—15	m.	
Sagitta enflata large form							
5	25.4	18.0	10—10	10—11	16—16	m.	SB112
6	25.7	18.0	10—10	9—9	16—17	m.	
7	26.0	18.0	9—9	9—9	7+*—15	m.	
8	26.5	18.0	9—10	10—10	14—15	m.	
9	27.0	18.0	10—10	10—11	15—16	m.	
10	27.0	17.0	9—10	9—9	15—15	m.	

Table 19. Armature formulae of *S. enflata*.
* Some torn out. SB···Shellback Exp.

shorter ovaries at maturity, then *gardineri* should be treated as a variety or even a distinct species.

9. *Sagitta lyra* KROHN

(Fig. 22)

The fully matured seminal vesicles of this species resemble closely that of *enflata*, nearly spherical in shape and rupture around the apex. The vesicles are situated near the rear end of the posterior fin, being widely separated from the caudal fin.

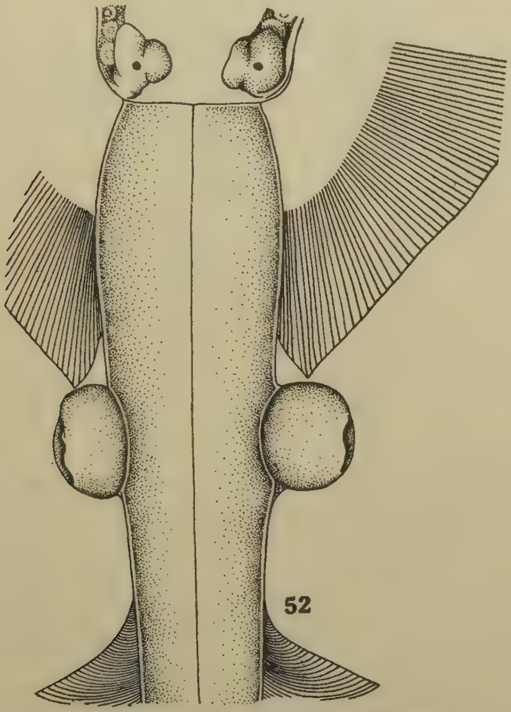

Fig. 22. *Sagitta lyra* KROHN. Seminal vesicles of a 32.5 mm long individual from SB 1, dorsal.

10. Other species of *Sagitta*

(Tables 20–22)

A few specimens of some other species were dissected to ascertain identification. Their armature formulae are given in small tables 20–22. Young individuals of *Sagitta pulchra* are sometimes provided with 7 hooks. Some specimens of *Sagitta minima* from the Shellback area seem to bear more teeth than the Eastropic specimens (SUND, 1959b). The formulae of *planctonis* seem to fall in the range of variations generally admitted for this species.

20

Sagitta pulchra							
1	7.2	22.7	7—7	6—6	10—10	im.	MP 14
2	15.7	20.7	5—6	6—6	13—13	m.	TP
3			6—6	8—8	12—13	m.	EQPH11

21

Sagitta minima							
1	6.2	17.9	7—8	4—5	11—12	m.	SB 90

22 Sagitta planctonis

No	body length	tail seg. in %	hook	ant. teeth	post. teeth	maturity	loc.
1	6.4mm	27.6	10—10	3—5	7—8	im.	SB 30
2	10.3	25.3	9—9	5—5	9—9	im.	SB170
3	19.8	26.2	9—9	8	14		SB 1
4	20.8	25.0	9—9	8	13		SB 1

Tables 20–22. Armature formulae of *S. pulchra* (20), *minima* (21) and *planctonis* (22). EQP···Equapac Exp., MP···Midpac Exp., SB···Shellback Exp., TP···Transpac Exp.

11. *Krohnitta subtilis* (GRASSI) and *K. pacifica* (AIDA)

(Fig. 23, Tables 23–24)

The mature seminal vesicles of *K. subtilis* are very elongate and touch both the posterior and the caudal fins; the rupture occurs at first at the antero-lateral corner of the vesicle (Fig. 23), but afterwards it extends to nearly the whole lateral

23

Krohnitta pacifica						
1	5.9	33.3	9—9	15—15	im.	SB 35
2	6.2	32.3	8—8	13—13	m	SB170
3	6.9	29.2	8—8	13—14	m.	SB 35
4	7.3	28.6	9—10	14—14	m.	SB 35
5	8.0	30.9	8—8	15—15	m	SB 35
6	8.0	33.3	9—10	15—15	m.	SB115
7	8.3	29.7	8—9	14—15	m	SB118

24

Krohnitta subtilis						
1	11.4	31.4	8—8	10—11	m.	SB170
2	12.0	32.4	7—7	11—12	m	SB170

Tables 23–24. Armature formulae of *K. pacifica* (23) and *subtilis* (24). SB···Shellback Exp.

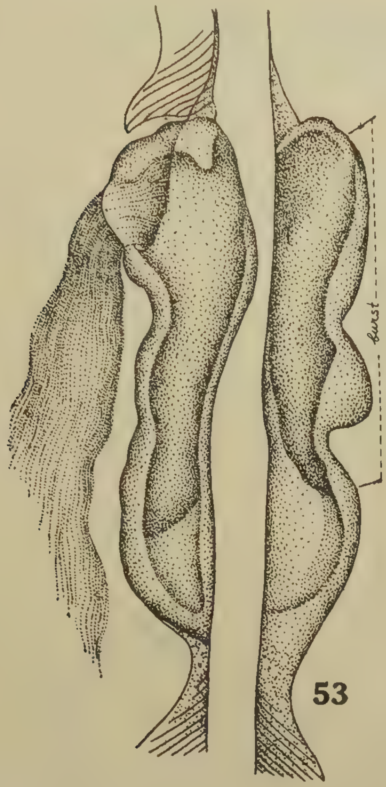

Fig. 23. *Krohnitta subtilis* (Grassi). Seminal vesicles of an individual from SB 44. ×125.

side leaving only a small posterior part of the vesicle intact. The Shellback specimens of *K. pacifica* seem to be provided with slightly more hooks than the Eastropic specimens (Sund, 1959b).

Distribution and Faunistic Notes

1. LAGOONS OF BAJA CALIFORNIA

(Fig. 24, Tables 25–26)

1) *Scammons lagoon.* This lagoon is situated approximately at 27°45′ N × 114° 10′ W (Fig. 24) and the shallow bottom is covered by eel grass. Ten plankton samples were taken with a small net at nine of the 17 stations in the lagoon. Only *S. tenuis* was found in six of the samples. Generally speaking, plankton samples from the outer stations (Sts. 10, 15 and 16) were characterized by a dominance of the copepod, *Paracalanus*, those from the middle part (Sts. 11 and 17) were densely populated by *Oithona* and the samples from the inner portion (Sts. 12–14) were

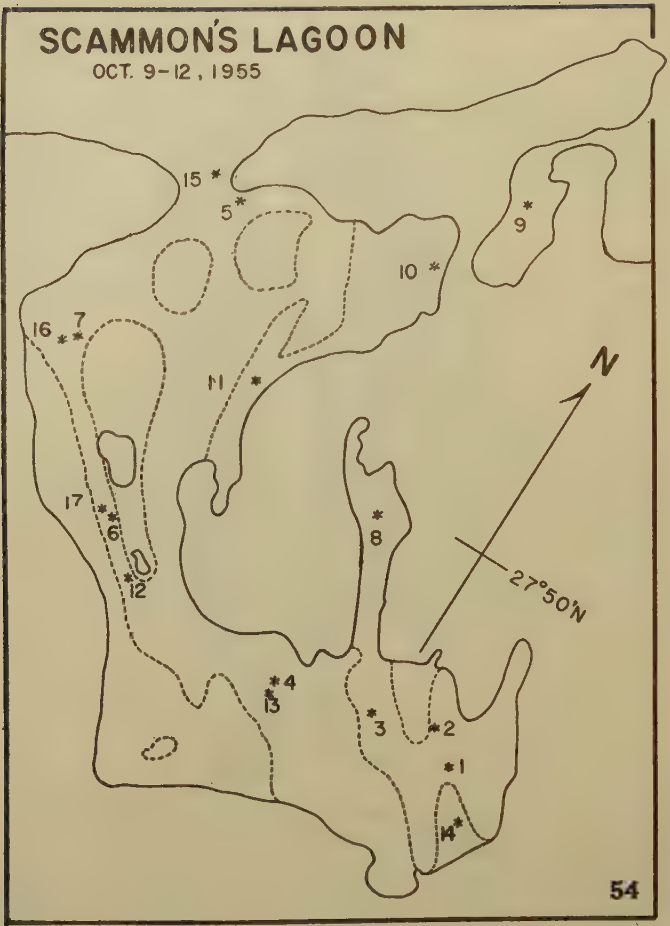

Fig. 24. Map of Scammons Lagoon, showing the sampling stations.

25

Stations / Body length	10	11	15A	15B	16	17	total
<3 mm	1	3	23	12	12	2	53
3.1 - 5 mm	3	7	14	20	13	15	72
5.1 - 7 mm	1	—	1	13	3	21	39
7.1 - 9 mm	—	—	4	2	2	10	18
9.1 - 10.7 mm	—	—	—	—	—	1	1
total	5	10	42	47	30	49	183
Salinity (‰)	36.3	36.7	34.7		37.6	38.8	

Table 25. Occurrence of *Sag. tenuis* in Scammons lagoon.

26

Stations / Body length	1	2	total
3.1 – 5 mm	1	4	5
5.1 – 7 mm		2	2
total	1	6	7

Table 26. Occurrence of *Sag. tenuis* in Manuela lagoon.

crowded with *Acartia*. However, on some tidal phase these copepods may occur mingled with one another or *Acartia* may be very abundant at the outer-most station (St. 15) where the water flows in or out very violently. The distribution of *S. tenuis* seemed to be confined to the *Paracalanus-Oithona* area at the time when the collections were made; none was found in the inner portion (Sts. 1–4, 6, 8, 12–14) where the salinity reached 39.5–47.9‰. The highest salinity recorded at stations where this chaetognath was found was 38.8‰ (St. 17) and the maximum body length measured on the collected specimens at these stations was 10.7 mm.

2) *Manuela lagoon*. A few specimens of *S. tenuis* were found in two plankton samples collected with a small net. Very probably *S. tenuis* is the only chaetognath, which can live in such lagoons situated along the coast of Lower California and characterized by comparatively high salinity.

2. THE INLET WATERS ALONG THE PACIFIC COAST OF JAPAN

A single haul with a small net, 17 cm in the mouth diameter, was made from 0–17 m in the morning of Oct. 7 during the Transpac Expedition near the entrance to Yokosuka Harbour in Tôkyô Bay. Eighty chaetognaths were found in this sample, all belonging to *S. crassa* f. *naikaiensis* which is known as a plankton indicator of the inlet waters, being found very abundantly and commonly in embayments along the coast of Japanese Islands.

3. *ELEGANS*-WATER IN THE NORTH PACIFIC

(Appendix table 2)

Of the samples of the Transpac Expedition 1953, thirty-nine (Nos. TP 19–50, 53, 61, 63–66 and 73) contain only cold water species, *Sagitta elegans* and *Eukrohnia hamata*, or only the former. *E. hamata* was found only at two stations (TP 20 and 21) and only a single individual in each case.

4. MIXING AREA OF THE *ELEGANS*-WATER AND THE WARM WATER

(Appendix table 3)

With regards to samples from the surface water above 50 m, *Sagitta minima* seems to be the commonest of five warm water species occurring throughout the whole mixing area. In the eastern part of the Pacific, *S. lyra* occurs rather regularly in the mixing area, while in the western half *S. enflata* joins the fauna and in more western part than 150° E, *S. bedoti* and *S. crassa* f. *naikaiensis* are added to the population. The occurrence of *S. lyra* has been reported by Lea (1955) along the west coast of the Queen Charlotte Islands, British Columbia, by Sund (1959) in the Gulf of Alaska, by Tchindonova (1955) in the southern part of the Bering Sea, and by Hida (1957) in the Transition Zone north of the Hawaiian Islands. The last author stated *Pterosagitta draco*, *S. hexaptera*, *S. serratodentata* and *S. bipunctata* decrease markedly in the transition zone, but on the contrary *S. lyra* increases there. Marumo and others (1958) also mention that besides *S. elegans*, *S. bedoti*, *S. minima* and *E. hamata*, *S. lyra* occurred in the upper 80 m layer at 40° N, 150° E (p. 183). The higher concentration of *S. minima* near the northern boundary of the warm water mass in the North Pacific is clearly illustrated by Bieri (1959). The occurrence of *S. bedoti* and *S. crassa* f. *naikaiensis* in the western mixing area is evidently a natural result of the distribution of *bedoti*-water as is shown later in the section on *bedoti*-water, and of course this phenomenon is also observable in the Japan Sea.

5. THE BLUE-GREEN WATER ALONG SOUTHERN CALIFORNIA

(Table 27)

Nineteen plankton samples were collected March 12–13, 1956 in the coastal blue-green water along the Californian coast from San Diego to Long Beach. A small net, 17 cm in the mouth diameter, was towed from 20–40 m to the surface. Chaetognaths, represented by a single species *S. friderici*, were found in sixteen of these samples. Since small, yound individuals were distributed widely in the surveyed area as shown in Table 27, it appears that this species propagates within this blue-green water. Of the 35 plankton samples collected off San Diego with a similar small net and stored at Scripps Institution, 27 contained *S. friderici* and some unidentifiable

27

Body length	Number of individual	Frequency of Occurrence
1 - 4 mm	92	16/16
5 - 8 mm	23	3/16
9 - 12 mm	3	1/16
13 - 16 mm	5	2/16
17 - 19 mm	4	2/16
total	127	

Table 27. Occurrence of *Sag. friderici* in the blue-green water along Souther California March 12–13, 1956.

juveniles or damaged specimens. Some cold water plankton animals, such as *Oikopleura labradoriensis* and *Fritillaria borealis* f. *typica*, were found rather commonly in this water, together with a neritic species such as *Oikopleura dioica*. Therefore. the blue-green water is apparently a mixture of northern cold subarctic water and coastal water, although no individual of *S. elegans* has ever been reported from the area. The details of the occurrence of *S. friderici* off California have been described by MICHAEL (1911), under the name *S. bipunctata*, and also refered by BIERI (1959).

6. *BEDOTI*-AREA

I. **Occurrence of *S. bedoti* in the eastern Pacific** (Fig. 25, Table 28)

The occurrence of *S. bedoti* in the eastern Pacific was first reported by BIERI (1957) from the waters off Peru. Later, the distribution of this species in the Shellback area was clearly illustrated in his second paper (1959). More recently the

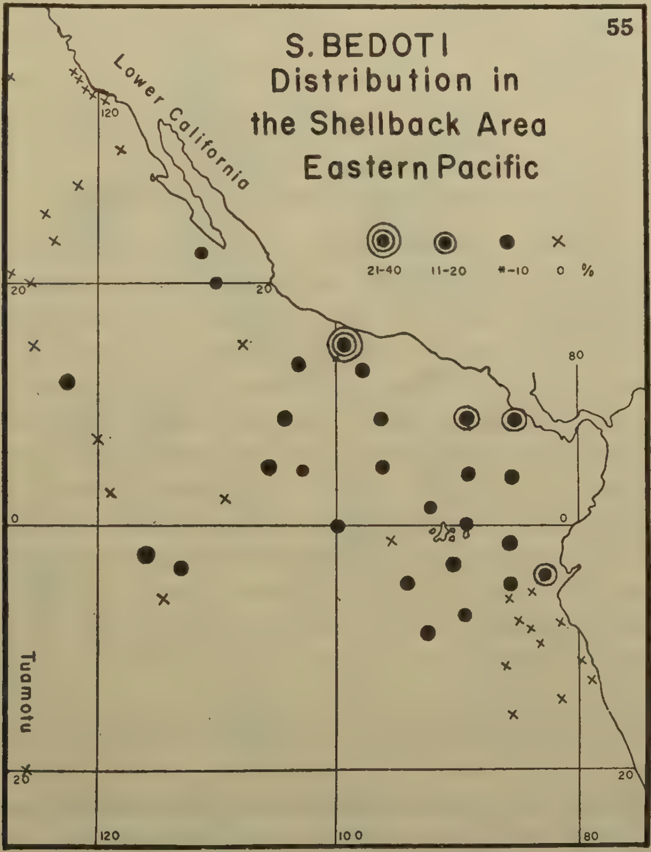

Fig. 25. Distribution of *Sagitta bedoti* in the Shellback area.

28

Stations	Number of ind.	%	bed./enf.
SB 20	1	*	*
SB 35	5	*	0.02
SB 44	6	*	0.02
SB 55	20	1	0.05
SB 60	38	4	0.19
SB 64	4	1	0.04
SB 68	137	22	0.77
SB 71	1	*	0.02
SB 75	12	3	0.17
SB 80	32	2	0.06
SB 90	1	*	*
SB 95	1	*	*
SB 100	15	1	0.02
SB 105	7	*	0.01
SB 109	101	12	0.54
SB 155	30	2	0.06
SB 160	11	1	0.03
SB 166	215	19	0.52
SB 170	299	15	0.33
SB 175	27	2	0.08
SB 180	41	2	0.11
SB 181	7	1	0.02
SB 187	131	7	0.16
SB 195	12	3	0.14
SB 200	105	5	0.09
SB 215	1	*	*
SB 217	2	*	*

* <1% or 0.01

Table 28. Occurrence of *S. bedoti* in the Shellback area.

presence of the species was reported by SUND (1959b and c) also in the area of the Eastropic Expedition. The species seems to be absent off northern-central Chile (FAGETTI; 1958a). Three additional papers dealing with the chaetognaths of the coastal waters of North America have appeared; namely MICHAEL (1911), LEA (1955) and SUND (1959a). In all of these reports *S. bedoti* was quite absent. I found this species in 27 of the 48 Shellback samples examined (Frequency of Occurrence 56%), of which the northernmost station was SB 217, the southernmost station SB 95 and the western-most station was SB 20. It was most abundant at stations along the coast between 15° N and 5° S, but decreases rather sharply in the offshore water. This species occurs in the Shellback area in rather large numbers at some stations, but yet the proportion of the species to the total chaetognaths is not high; it was 22% at SB 68, but most frequently it is less than 5%. The proportion of *S. bedoti* to *S, enflata* (*bedoti*/*enflata*) is especially low, never reaching 0.8 and mostly less than 0.5.

II. **Occurrence of *S. bedoti* at the western stations near Japan** (Fig. 26, Tables 29–32).

The Occurrence of this species in the waters around Japan has been reported repeatedly (AIDA 1897, as *S. bipunctata*; TOKIOKA 1939, 1940, 1951, 1954 and 1957; FURUHASHI 1953, BIERI 1959). Besides, there are several data reporting the occur-

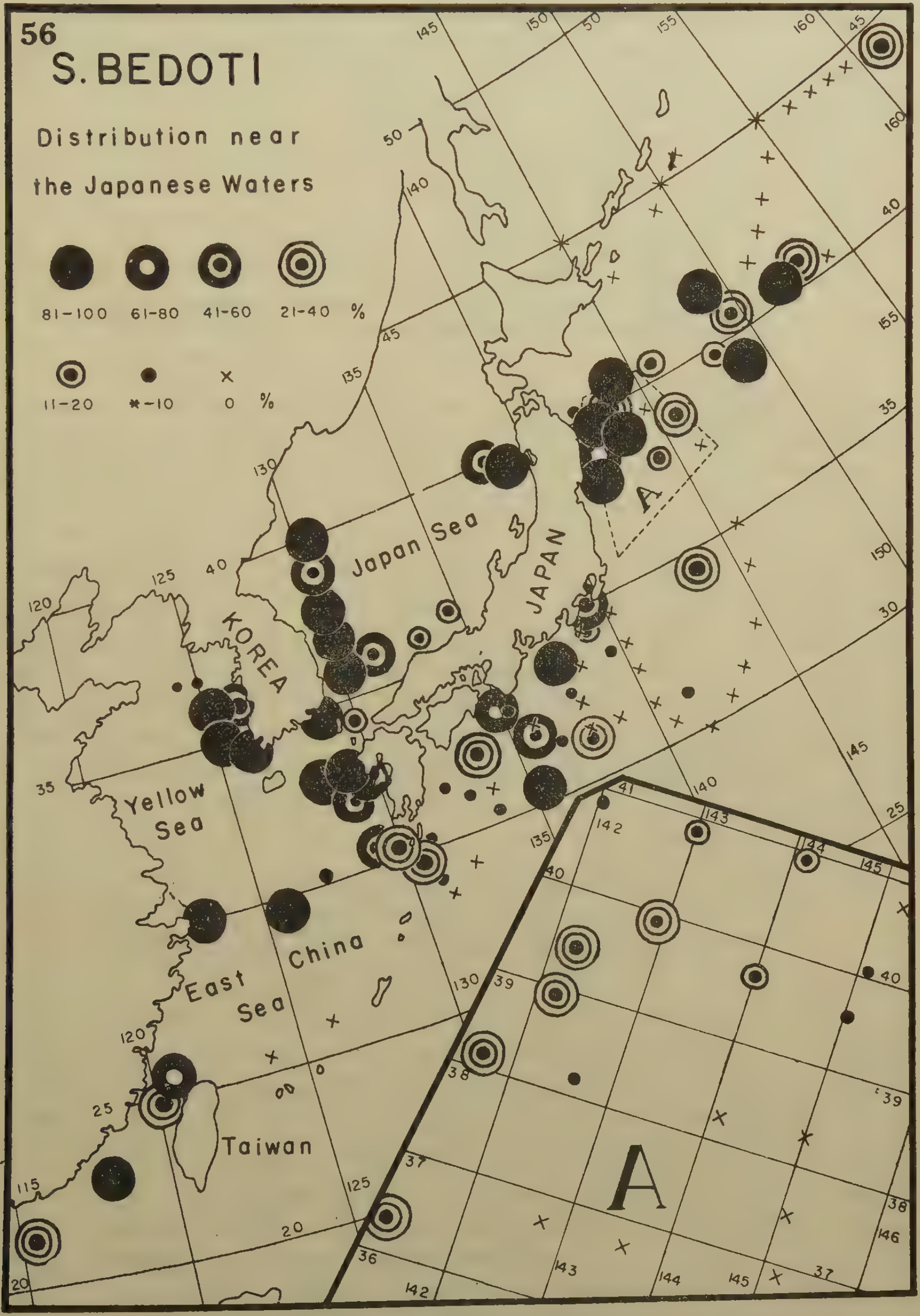

Fig. 26. Distribution of *Sagitta bedoti* in the Japanese and adjacent waters.

29

Stations	Number of ind.	%	bed./enf.	Stations	Number of ind.	%	bed./enf.
TP 59A	6	27	∞	TP 76	60	29	2.61
TP 69	12	34	∞	TP 78	58	32	6.44
TP 70	3	19	1.50	TP 93	1	1	0.02
TP 71	3	11	∞	TP 95	2	2	0.08
TP 74	6	4	0.33	TP 99	2	1	0.04

Table 29. Occurrence of *S. bedoti* at the western stations of the Transpac Expedition near Japan.

30

Stations	Number of ind.	%	bed./enf.	Stations	Number of ind.	%	bed./enf.
J 1	16	6	0.73	J 8	1	33	∞
J 2	1	13	∞	J 9	4	25	∞
J 3	1	17	∞	J 10	2	25	2.00
J 5	2	9	2.00	J 11	9	23	9.00
J 6	1	3	0.33	J 12	1	3	0.50
J 7	18	16	3.00	J 19	17	24	1.42

Table 30. Occurrence of *S. bedoti* in the material collected by a Japanese survey ship in the offshore waters off North-Eastern Honsyû, Japan.

31

Percentage of *S. bedoti*	Eastern Pacific	Western Pacific
* – 5%	22	6
6 – 10%	1	2
11 – 20%	3	5
21 – 30%	1	6
31 – 40%	0	3
total	27	22

* less than 1%

Table 31. Comparison of the percentage of *S. bedoti* to the total chaetognaths between the eastern and western sides of the Pacific.

32

Eastern Pacific			Western Pacific		
*	5	27	*	0	7
0.01 – 0.09	13		0.01 – 0.09	3	
0.10 – 0.49	6		0.10 – 0.49	2	
0.50 – 0.99	3		0.50 – 0.99	2	
1.00 – 4.99	0	0	1.00 – 4.99	6	15
5.00 – 9.99	0		5.00 – 9.99	2	
10.00 – ∞	0		10.00 – ∞	7	
total	27		total	22	

Table 32. Frequency of occurrence of respective values of the ratio *bedoti/enflta* in the eastern and western sides of the Pacific.
* less than 0.01

rence of this species off the Pacific coast of middle Japan (Uyeno and Furuhashi 1955 and others) and off northeastern Japan (Marumo 1955 and others). I found *S. bedoti* in 10 of the Transpac samples form the stations near Japan and in 12 of the 19 samples (Frequency of Occurrence 63%) collected off north-eastern Japan by a Japanese survey ship and presented to the Transpac Expedition of Scripps Institution. As the samples were collected with small net, only a small number of this species occurred in the samples. However, when the proportion of this species is referred to total chaetognaths higher percentages seem to occur more frequently in the western than in the eastern Pacific (Table 31); and this tendency is more pronounced when the values of *bedoti/enflata* are computed and compared with those in the eastern Pacific (Table 32). The northern-most latitude where this sagitta occurred was 44°06′ N and the eastern-most limit of the distribution was 161°39′ E,

III. Other available data concerning the occurrence of *S. bedoti*.

a) *The waters around Japan.*

i. Off north-eastern Honsyû, north to 40° N. (Table 33). The results of the examination of plankton samples collected by the Sôyô-Maru, a survey ship of the former Central Fisheries Experimental Station in Tôkyô, in the years 1934 and 1937–39 (Tokioka, 1957) show that *S. bedoti* occurred commonly in the mixing area of the cold Oyasio and the warm Kurosio in the southern part of this area. Here this species constitutes high percentages of the population, 33–100%, the average being 84%. The northern-most station where *S. bedoti* occurred in this material was 42°05′ N and the eastern-most station was 154°14′ E.

ii. Off north-eastern Honsyû, south to 40° N. (Table 33). All of the seven samples mentioned in the preceding section, which were collected in this area, contained a large number of *S. bedoti*; its percentage was also very high ranging from 15 to 100%

33

Percentage	North to 40°N		South to 40°N	
* - 5%		1	—	2
6 - 10%	—		—	
11 - 20%	—		1	
21 - 30%	—		1	
31 - 40%	1		—	
41 - 50%	—		—	
51 - 60%	—	5	—	5
61 - 70%	—		1	
71 - 80%	—		—	
81 - 90%	2		—	
91 - 100%	3		4	
total	6		7	

Table 33. Occurrence of *S. bedoti* in the waters off North-Eastern Honsyû, Japan (Sôyô-Maru material).
* present, but less than 1%.

34

Percentage	off the South-Western Honsyû		Sagami Bay	
* - 5%	3	9	—	4
6 - 10%	2		—	
11 - 20%	1		2	
21 - 30%	2		1	
31 - 40%	—		1	
41 - 50%	1		—	
51 - 60%		3	2	2
61 - 70%	—			
71 - 80%	2		—	
81 - 90%	1		—	
total	12		6	

Table 34. Occurrence of *S. bedoti* in the waters off South-Western Honsyû, Japan (Sôyô-Maru material). * present, but less than 1%.

and 71% on an average. The greater part of this area is one of mixing between the Oyasio and the Kurosio, and the abundance of *S. bedoti* along the boundary between these two water-masses in this area has also been reported in the oceanographic reports (Kaiyô-Hôkoku) published by the Meteorological Department of Japan (1956–1958). MARUMO (1955) stated that *S. bedoti* was comparatively abundant in the Kurosio and in the area where the Oyasio and the Kurosio mingle. This is clearly illustrated also by BIERI (1959).

35

<table>
<tr><th></th><th colspan="15">Coastal Water</th><th colspan="30">Proper part of Kurosio</th><th colspan="2">offshore water beyond Kurosio</th></tr>
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Table 35. Individual number of *S. bedoti* occurred at respective stations in the Kurosio area off the South-Western Honshû, Japan. (Data offered by the Kôbe Marine Observatory.)

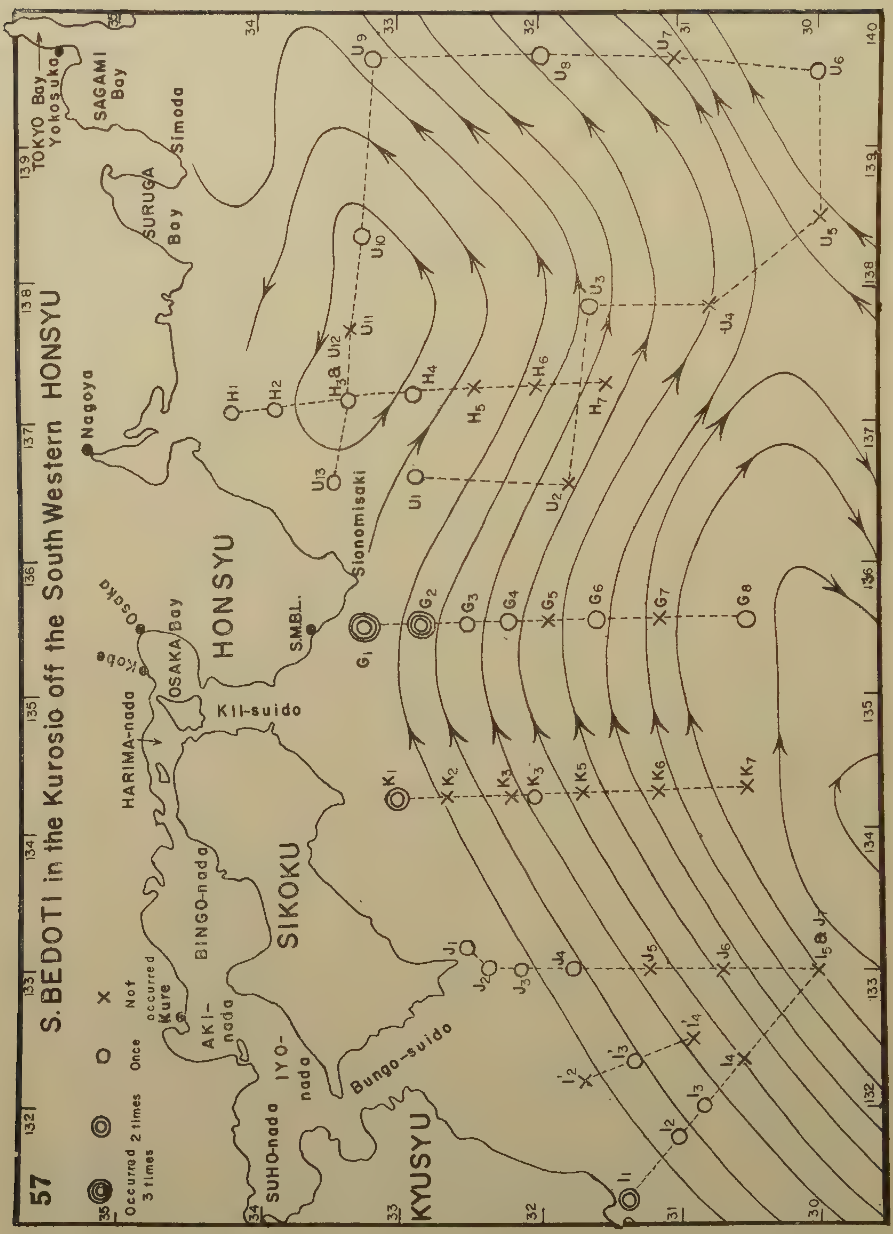

Fig. 27. Occurrence of *Sagitta bedoti* in the Kurosio region off the South Western Honsyû, Japan.

iii. Off south-western Honsyû. (Fig. 27, Tables 34–38). In 12 of the 13 samples of the Sôyô-Maru material (Frequency of Occurrence 92%), collected in this area, from 2 to 82% of the chaetognath population consisted of *S. bedoti* (31% on an average) (Table 34). Here, *S. bedoti* appeared to occur more abundantly in the eastern part of this area than in the western part near Kyûsyû.

Concerning the distribution of *S. bedoti* in the southern waters off Honsyû, UYENO and FURUHASHI (1955a and 1955b) showed that this species occurred in the coastal part of the Kurosio and in the axial portion (the most strongly flowing portion) of the current, but it was quite absent in the counter current of the Kurosio far beyond the axial portion. Prior to reading these papers, I asked to Mr. FURUHASHI of the Kôbe Marine Observatory to let me see the data to ascertain the details of the occurrence of this species. Very kindly, Mr. FURUHASHI sent me the detailed data and allowed me so generously to quote and publish them in my paper in his letter of

36 Table 36. Occurrence of *S. bedoti* in Tôkyô Bay (MURAKAMI, 1957).
* present, but less than 1%.

Outer part	May 15–17 1947	Sept. 11–13 1947	Nov. 19–22 1947	Dec. 6–7 1947	Mar. 17 1948
0	3	8	6	4	2
*-5%	2	—	—	—	—
6-10%	2	—	2	—	—
11-20%	—	—	3	1	—
21-30%	1	—	1	1	—
31-40%	—	—	2	1	—
41-50%	—	—	3	—	—
51-60%	—	—	1	1	—
Occurrence	5	0	12	4	0
mean	10	—	30	33	—

Table 36–1

Central part	May 13–15 1947	Sept. 9–11 1947	Dec. 4–6 1947	Mar. 12–17 1948
0	15	15	10	13
*-5%	—	—	3	2
6-10%	—	—	2	—
Occurrence	0	0	5	2
mean	—	—	4	2

Table 36–2

37

Inland Sea	Kii Channel		Ôsaka Bay		Harima Nada		Bingo Nada		Aki Nada		Suô Nada		Iyo Nada		Bungo Channel	
Number of Samples	186		281		132		274		92		85		131		12	
* - 5%	68	107	13	23	12	17	6	6	1	1	—	0	2	6	—	2
6 - 10%	17		3		3								1		1	
11 - 20%	13		6		1		—				—		1		—	
21 - 30%	5		1		—				—				1		—	
31 - 40%	3		—		—		—		—		—		—		—	
41 - 50%	1		—		1		—		—		—		1		1	
51 - 60%	5	16	—	1	1	1	—	0	—	0	—	0	—	1	—	1
61 - 70%	5		—		—		—		—		—		1		—	
71 - 80%	2		—		—		—		—		—		—		—	
81 - 90%	—		—		—		—		—		—		—		—	
91 - 100%	4		1		—		—		—		—		—		1	
Occurrence	123		24		18		6		1		0		7		3	
Frequency of Occurrence	66%		9		14		2		1		0		5		25	
mean percentage	16%		11		10		1		2		0		24		50	

Table 37. Occurrence of *S. bedoti* in the Inland Sea (Murakami, 1957 and 1959).
* present, but less than 1%.

38

Ôsaka Bay 1938	
Number of Stations	36
* - 5%	11
6 - 10%	2
Occurrence	13
Frequency of Occurrence	36%
mean Percentage	3%

Table 38. Occurrence of *S. bedoti* in Ôsaka Bay (Tokioka, 1939).
* present, but less than 1%.

May 9, 1955. Moreover, he stated in his letter of July 6, 1955 that *S. bedoti* seemed to disappear in the waters 40–50 miles off Sionomisaki. All the samples were collected from 100 m to the surface with the 0–net of the Kôbe Marine Observatory, constructed of No. 3 gauze and with the diameter of the mouth adjusted so as to cut 1/10 m². *S. bedoti* occurred in 17 of 29 samples (Frequency of Occurrence 59%) obtained in the coastal waters, in 14 of 58 samples from the proper part of the Kurosio (Frequency of Occurrence 24%) and in 2 of 9 samples from the offshore waters beyond the proper part of the Kurosio (Frequency of Occurrence 22%) (Table 35). The average number of specimens per haul was 10.9 in the coastal water, 4.8 (excluding the unusual occurrence of 96 individuals at G_3 in March 1955) in the axial part of the Kurosio and 3.5 in the offshore water beyond the Kurosio. It is evident that the species is found abundantly near the coast and diminishes markedly towards the open sea, although some small masses of the coastal water containing many *S. bedoti* may be carried, across the Kurosio, into the more offshore waters beyond the current by some counter currents and contrarily some masses of the far offshore water containing few *S. bedoti* may drift just near the shore of the Pacific coast of middle Japan.

In addition to the coastal waters of this region of Japan, *S. bedoti* is found in the following localities:

A) Sagami bay (Table 34). The first record of *S. bedoti* in Japanese waters was in Misaki Harbour in Sagami Bay by AIDA (1897) under the name of *S. bipunctata*.

All of the six samples of the Sôyô-Maru material collected in this bay included this species which constituted from 13 to 53% (33% on an average) of the total chaetognaths. While I was working at the Mitsui Institute of Marine Biology in 1937–38, I very frequently collected chaetognaths from the surface water of Sagami and Suruga bays, near the laboratory of the Institute, by using KITAHARA's quantitative net. In this material, I found about 1300 *S. bedoti*, this was approximatately 16% of all chaetognaths collected.

B) Tôkyô Bay (Table 36). MURAKAMI (1957) made a series of observations on the distribution of chaetognaths in this bay in the years 1947–48. When the bay is divided into three areas, an inner part inside a line connecting the estuaries of the River Rokugô and the River Yôrô, an outer part outside a line connecting the capes of Kannon-saki and Futtu-saki and a central part between these two, *S. bedoti* occurred most frequently (Frequency of Occurrence 48%) in the outer part and less frequently (Frequency of Occurrence 12%) in the central part, but it did not occur in any of the twenty-eight samples hauled in the inner part. The percentage of *S. bedoti* to the total chaetognaths ranged from 2 to 57 in the outer part, but from 1 to 8 in the middle portion. Higher percentages of the chaetognath population in the inner and middle portions are made up of *S. crassa* and its form *naikaiensis*.

C) Inland Sea and adjacent areas (Tables 37–38, see also Fig. 27). MURAKAMI (1957 and 1959) gives details of the occurrence of chaetognaths in vast plankton samples collected in the Inland Sea and adjacent areas in the years 1951–1957. His data on *S. bedoti* are arranged here in Table 37 so as to show its abundance in respective sections of the area under consideration. *S. bedoti* enters the Inland Sea from both Kii and Bungo Channels, but diminishes markedly towards the middle part of the Sea, where *S. crassa* and especially its forma *naikaiensis* are very abundant. In Kii-Channel the precentage of *S. bedoti* is very often much lowered by dense population of *S. enflata*. I made four hauls in Kii-Channel in 1938; *S. bedoti* occurred in three of these samples, its percentage varies from 3 to 20, 13 on an average (1939). In February 1954, a dense patch of chaetognaths appeared near the Seto Marine Biological Laboratory facing Kii-Channel, a small part of this patch was collected and 13 species were identified in 1112 specimens. Among these only five individuals of *S. bedoti* occurred (TOKIOKA, 1954a). In Ôsaka Bay, this species occurs

39

Southern Waters off Kyusyu	TOKIOKA 1940		Material of Sôyô-Maru	
Number of Samples	16		6	
* - 5%	1	11	2	4
6 - 10%	3		—	
11 - 20%	4		—	
21 - 30%	2		—	
31 - 40%	1		2	
41 - 50%	—		—	
51 - 60%	1	1	—	0
Occurrence	12		4	
Frequency of Occurrence	75%		67%	
mean Percentage	20%		20%	

Table 39. Occurrence of *S. bedoti* in the waters off Southern Kyûsyû, Japan.
* present, but less than 1%.

40

Western Waters off Kyûsyû		
Number of Samples	9	
* - 5%	1	2
6 - 10%	—	
11 - 20%	—	
21 - 30%		
31 - 40%	1	
41 - 50%	—	
51 - 60%	2	6
61 - 70%	1	
71 - 80%	—	
81 - 90%	1	
91 - 100%	2	
Occurrence	8	
Frequency of Occurrence	89%	
mean Percentage	62%	

Table 40. Occurrence of *S. bedoti* in the waters off Western Kyûsyû, Japan. (TOKIOKA, 1940).
* present, but less thun 1%.

more abundantly in the western half along Awazi Island. Of 36 samples hauled in 1938 in Ôsaka Bay by myself, *S. bedoti* occurred in 13 samples (Frequency of Occurrence 36%) and its percentage varied from 1 to 10. It occurred mostly near the south-western and north-western channels leading respectively to Kii-Channel and Harima-Nada (TOKIOKA, 1939). The species has never been found in any of the small embayments situated in the central part of the Inland Sea. For instance, none of the 31 plankton samples hauled in Kaida Bay in the years 1950–1951 nor 115 samples hauled in Kasaoka Bay in the years 1952–53 contained *S. bedoti* (MURAKAMI, 1957).

iv. The southern waters off Kyûsyû (Table 39). The data found in my previous paper (1940) and those of the Sôyô-Maru material (TOKIOKA, 1957) are available. The highest percentage was 59% found in the data of 1940. The density of *S. bedoti* seems to fluctuate rather violently in this area.

v. The western waters off Kyûsyû (Table 40). Only the data found in my paper of 1940 are available at present.

vi. The Korea Straits (Table 42). The data in my paper of 1940 show that *S. bedoti* is abundant in this area as well as in the Japan Sea.

vii. The Japan Sea (Table 41). The samples dealt with in my paper of 1940 were collected mostly along the eastern coast of Korea, not far from the land. All the data quoted in Table 41 are from samples collected at stations situated in the warm water region of the Japan Sea. At stations in the mixing area between the cold

41

The Japan Sea	TOKIOKA 1940		TOKIOKA 1951 Surface hauls		TOKIOKA 1951 50～350 m to 0 m		FURUHASHI 1953	
Number of Samples	21		66		35		4	
* - 5%	—	5	—	3	10	32	—	4
6 - 10%	—		—		10		1	
11 - 20%	1		1		3		1	
21 - 30%	2		1		2		2	
31 - 40%	1		1		5		—	
41 - 50%	1		—		2		—	
51 - 60%	3	16	—	2	—	1	—	0
61 - 70%	2		—		—		—	
71 - 80%	1		—		1		—	
81 - 90%	4		—		—		—	
91 - 100%	6		2		—		—	
Occurrence	21		5		33		4	
Frequency of Occurrence	100%		8%		94%		100%	
mean Percentage	68%		56%		17%		18%	

Table 41. Occurrence of *S. bedoti* in the Japan Sea.
* present, but less than 1%.

42

	The Yellow Sea		The Korea Straits	
Number of Samples	19		32	
* - 5%	3	5	—	10
6 - 10%	—		2	
11 - 20%	—		2	
21 - 30%	1		3	
31 - 40%	—		2	
41 - 50%	1		1	
51 - 60%	—	7	2	19
61 - 70%	—		2	
71 - 80%	—		1	
81 - 90%	—		1	
91 - 100%	7		13	
Occurrence	12		29	
Frequency of Occurrence	63%		91%	
mean Percentage	62%		69%	

Table 42. Occurrence of *S. bedoti* in the Yellow Sea and the Korea Straits (TOKIOKA, 1940).
* present, but less than 1%.

Liman Current and the warm Tusima Current, *S. bedoti* constitutes fairly high proportion of the chaetognaths, although its percentage is often lowered by the dense population of *S. minima.*

b) *The Yellow Sea* (Table 42)
According to the data of the material treated in my previous paper of 1940, *S. bedoti* seems to be very abundant at stations in this sea except for northern stations and excluding the samples gathered in the very surface layer, where the salinity of the water is rather low and only *S. crassa* is dominant. In Table 42, only the data of samples collected at stations situated south of the latitude of the point of Shantung peninsula in North China are treated. Both the frequency of occurrence and the mean percentage should be much raised if more stations in the northern part are omitted from consideration.

c) *The East China Sea* (Table 43).
S. bedoti was very abundant at stations around the Chu-San Islands near the estuary of the Yang-Tse River (TOKIOKA, 1940). In the East China Sea, it seems to be very common in the western half near the continent, but gradually decreases towards the east and is scarcely found near the Ryûkyû Islands. The Sôyô-Maru material con-

43

The East China Sea	Sôyô-Maru material		Around the Chu-san Islands	
Number of samples	4		11	
*-5%	—	1	—	1
6-10%	1		—	
11-20%	—		—	
21-30%	—		1	
31-40%	—		—	
41-50%	—		—	
51-60%	—	1	—	10
61-70%	—		1	
71-80%	—		—	
81-90%	—		—	
91-100%	1		9	
Occurrence	2		11	
Frequency of Occurrence	50%		100%	
mean Percentage	50%		88%	

Table 43. Occurrence of *S. bedoti* in the East China Sea.
* present, but less than 1%.

tains two samples from the Taiwan Straits, in both of which *S. bedoti* occupies very high percentage, respectively 54 and 21%. Mr. Enomoto of the Seikai Regional Fisheries Research Laboratory at Nagasaki stated in his letter of March 27, 1957 that this sagitta seemed to be the most important of all chaetognaths in the East China Sea, when he sent me several specimens of *S. bedoti* for identification, which were collected in June 1956 near the middle of that sea.

d) *The South China Sea* (Table 44)

In this area, *S. bedoti* maintains still higher percentages in the north-western portion (18–81%), but decreases greatly near Hainan Island (less than 3%). It is recorded also from the coastal waters of Annan (Serene, 1937), but there it forms only a small part of the chaetognath fauna (Hamon, 1956). The minor form occurred in the Bay of Nhatrang-Cauda at a frequency of 6–76%, but it occupied only less than 1.7% of the whole population.

44

The South China Sea		
Number of samples	9	
* - 5%	3	5
6 - 10%	—	
11 - 20%	1	
21 - 30%	1	
31 - 40%	—	
41 - 50%	—	
51 - 60%	—	1
61 - 70%	—	
71 - 80%	—	
81 - 90%	1	
Occurrence	6	
Frequency of Occurrence	67%	
mean Percentage	22%	

Table 44. Occurrence of *S. bedoti* in the South China Sea (Sôyô-maru material).
* present, but less than 1%.

e) *The waters around the Philippines and adjacent waters* (Tables 45–46)

According to Michael (1919), during the Philippine Expedition by the Albatross, *S. bedoti* occurred at only four stations in the Sulu Sea and adjacent waters. The frequency of occurrence was 9% of the total 46 sampling stations.

The south-eastern waters off Mindanao (Mindanao Current): During the Snellius

45

Sulu Sea	Number of Sampling Sts.	Frequency of Occurrence	mean Percentage
Siboga-Exped.	5	60%	6.1 (1 station)
Snellius-Exped.	6	83%	4 (1~5%)

Table 45. Occurrence of *S. bedoti* in the Sulu Sea.

46

Mindanao Current	Number of Sampling Sts.	Frequency of Occurrence	mean Percentage
Siboga-Exped.	2	50%	+
Snellius-Exped.	30	43%	2% (* ········· 2 1-5% ··· 11)

Table 46. Occurrence of *S. bedoti* in the south-eastern waters off Mindanao.
* less than 1%.

Expedition, the frequency of occurrence of this species was higher in the southern part than in the northern part of this area.

f) *The waters around the Malay Archipelagoes* (Tables 47–51).

Since Béraneck's (1895) original description of *S. bedoti* was published, stating that—"It is abundant in the bay of Amboina (p. 152)"—, there have been published three important paper: Fowler's report on the material of Siboga-Expedition (1906), Oye's paper on the chaetognaths of the Java Sea (1918) and Schilp's extensive work on the material of the Snellius Expedition (1941). According to Oye's data, *S. bedoti* seems to be more abundant in the western part than in the eastern part of the Java Sea.

g) *The waters adjacent to the above-mentioned area* (Tables 52 and 53).

The stations of the Snellius Expedition in the Arafura Sea were situated in the north-western part of the sea, while Tokioka's material came from the south-western part of the sea. Besides, Tokioka (1942) states that *S. bedoti* was common in the plankton samples taken near the estuary of the River Liverpool, Arnhem Land.

h) *The Indian Ocean* (Fig. 28, Table 54).

The record of *Sagitta polyodon* by Doncaster (1903) from the waters around the Maldive Islands is the first one dealing with the occurrence of *S. bedoti* in this ocean. There, this species was "found in fair abundance in both winter and spring (p. 213)". During the Deutsche Südpolar Expedition by the "Gauss" (Ritter-Záhony,

47

Java Sea	Siboga 1906		Oye 1918		Snellius 1941	
Number of sampling stations	10		77		24	
*	7	8	—	32	2	20
1-5%	1		19		11	
6-10%	—		6		2	
11-15%	—		7		5	
16-20%	—	0	4	8	1	1
21-30%	—		3		-	
31-40%	—		—		—	
41-50%	—		1		—	
Occurrence	8		40		21	
Frequency of Occurrence	80%		52%		88%	
mean Percentage	+		10%		6%	

Table 47. Occurrence of *S. bedoti* in the Java Sea.
* present, but less than 1%.

48

Celebes Ses	Siboga 1906		Snellius 1941	
Number of sampling stations	9		44	
+ or *	4	7	1	29
1 - 5%	2		19	
6 - 10%	1		8	
11 - 15%	—		1	
16 - 20%	—	0	2	4
21 - 30%	—		—	
31 - 40%	—		2	
Occurrence	7		33	
Frequency of Occurrence	78%		75%	
mean Percentage	3% (4 stations)		7%	

Table 48. Occurrence of *S. bedoti* in the Celebes Sea.
* less than 1%.

49

	Banda Sea				Moluccas Archipelago			
	Siboga 1906		Snellius 1941		Siboga 1906		Snellius 1941	
Number of sampling stations	15		68		23		53	
+ or *	12	12	2	43	11	19	1	34
1 - 5%	—		25		3		19	
6 - 10%	—		12		4		10	
11 - 15%	—		4		1		4	
16 - 20%	1	1	4	9	—	0	—	4
21 - 30%	—		2		—		2	
31 - 40%	—		3		—		—	
41 - 50%	—		—		—		1	
100%	—		—		—		1	
Occurrence	13		52		19		38	
Frequency of Occurrence	87%		76%		83%		72%	
mean Percentage	+		8%		7% (8 stations)		7%	

Table 49. Occurrence of *S. bedoti* in the Banda Sea and the Moluccas Archipelago.
* less than 1%.

50

Flores Sea	SIBOGA 1906		SNELLIUS 1941	
Number of sampling stations	11		42	
+ or *	6	6	2	27
1 - 5%	—		10	
6 - 10%	—		8	
11 - 15%	—		7	
16 - 20%	—	0	1	2
21 - 30%	—		1	
Occurrence	6		29	
Frequency of Occurrence	55%		69%	
Mean Percentage	+		8%	

Table 50. Occurrence of *S. bedoti* in the Flores Sea.
* less than 1%.

51

Boni Bay in the Flores Sea	SNELLIUS 1941	
Number of sampling stations	4	
1 - 5%	1	2
6 - 10%	1	
11 - 15%	—	
16 - 20%	1	2
33%	1	
Occurrence	4	
Frequency of Occurrence	100%	
Mean Percentage	16%	

Table 51. Occurrence of *S. bedoti* in Boni Bay, the Flores Sea.

52

	Timor Sea			Arafura Sea			
	Snellius 1941		Tokioka 1956	Snellius 1941		Tokioka 1956	
Number of sampling stations	12		6	18		49	
1 - 5%	3	7	0	3	9	4	21
6 - 10%	3			5		10	
11 - 15%	1			1		7	
16 - 20%	1	2		3	3	9	20
21 - 30%	1			—		7	
31 - 40%	—			—		1	
41 - 50%	—			—		3	
Occurrence	9		0	12		41	
Frequency of Occurrence	75%		0	67%		84%	
Mean Percentage	9%		0	9%		17%	

Table 52. Occurrence of *S. bedoti* in the Timor Sea and the Arafura Sea.

53

Savu Sea	Snellius 1941		Siboga 1906
Number of sampling stations	20		1
1 - 5%	5	11	0
6 - 10%	3		
11 - 15%	3		
16%	1	1	
Occurrence	12		0
Frequency of Occurrence	60%		0
Mean Percentage	7%		0

Table 53. Occurrence of *S. bedoti* in the Savu Sea.

54	Visakhapatnam Oct. 1952~Apr. 1953		Centra plart of the Indian Ocean		
	10~15 miles off shore	more than 20 miles off shore	Tokioka 1956		
Number of sampling stations	13	21	Number of sampling stations	26	
1 - 5%	1		1 - 5%	2	12
6 - 10%	—	—	6 - 10%	6	
11 - 20%	—	1	11 - 15%	4	
21 - 30%	1	—	16 - 20%	4	9
33%	—	1	21 - 30%	5	
Occurrence	2	2	Occurrence	21	
Frequency of Occurrence	15%	10%	Frequency of Occurrence	81%	
Mean Percentage	15%	22%	Mean Percentage	15%	

Table 54. Occurrence of *S. bedoti* in the Indian Ocean.

1911), *S. bedoti* was collected in the south-western part of the ocean from the surface water off Port Natal. On the opposite side in this ocean, it is reported from Sharks Bay on the western coast of Australia (Ritter-Záhony, 1910a). During the "Sea lark" Expedition in the western half of the Indian Ocean in 1905, *S. bedoti* occurred in only small numbers, the frequency of occurrence was also quite low, 12% (Burfield, 1926). Ghirardelli (1948) reported that this sagitta occurred in the waters along the coast of Somaliland at a frequency of 34% (of 44 stations) and the number of specimens throughout the whole samples constituted 4% of the total chaetognaths.

In the Bombay Harbour, this sagitta is the commonest species and is found there throughout the year in considerably large numbers (Lele and Gae, 1936). On the eastern side of India, the species was not fonnd in coastal water of Madras (John, 1933), but later its occurrence in this region was ascertained by Subramanyam (1940). Satyanarayana Rao (1958) has recently shown that *S. bedoti* is as common as *S. enflata* throughout the year in Lawson's Bay, Waltair, East India. It is most abundant in January-February and June-July, but it diminishes in the offshore water and it is quite absent there in February and October. Further, Satyanarayana Rao and Ganapati (1958) discuss the occurrence of *S. bedoti* in the waters off Visakhapatnam Harbour south of Waltair as follows: the species is "very common in the inshore waters during most of the year; recorded rarely in the offshore waters, mostly surface dwelling (p. 150)". My examination (Tokioka, 1956) of 26 plankton samples collected in the years 1954–1955 in the central part of the Indian Oean showed that this sagitta was one of the commonest species in this area. Also, I had an opportunity to examine three plankton samples from the north-eastern part of this ocean, near Nicobar, Nias and Bali-Lombok. In each of these samples, *S. bedoti* was found,

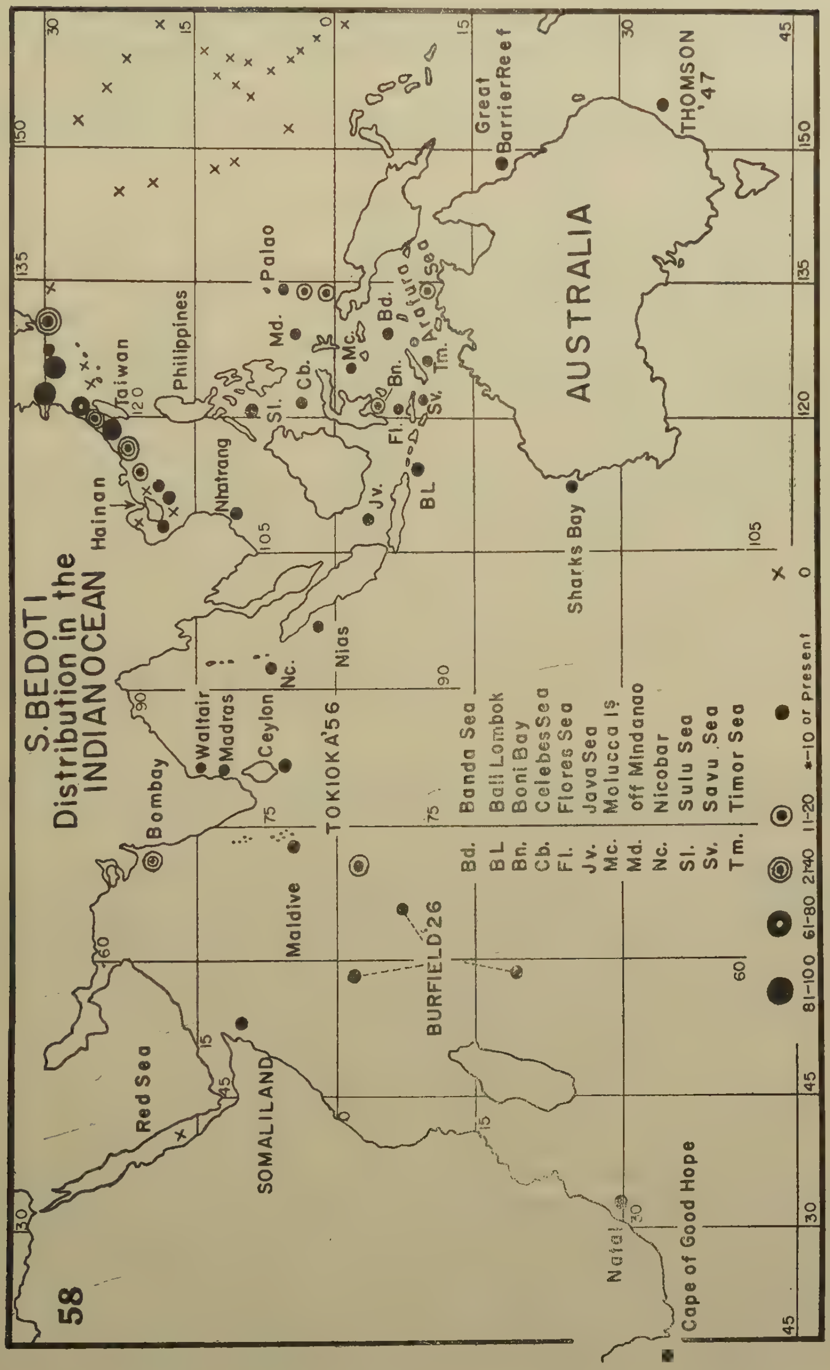

Fig. 28. Distribution of *Sagitta bedoti* in the Indian Ocean.

though only as 4, 3 and 9 percent of the whole population respectively. *S. bedoti* was not found by Steinhaus (1896) in the southern part of the Indian Ocean nor was it found during the Gazelle Expedition (Ritter-Záhony, 1909b). Gray (1923) also failed to find this species in samples taken in the southern Indian Ocean. In the Red Sea, *S. bedoti* was not found by either Pola (Ritter-Záhony, 1909a), Snellius, nor Cherso (Ghirardelli, 1948).

i) *The waters along the eastern coast of Australia.*

Although both Johnston and Taylor (1919) and Tokioka (1940b) could not find this sagitta in the southern part of this area, Thomson (1947) found it in the south-eastern waters of Australia and Burfield (1950) in the Great Barrier Reef region. In the south-eastern waters, it occurred at 25 stations, this constitutes 9.1% of all sampling stations. According to Fig. 4 in Thomson's paper, it was "infrequent" in the area northward to 28°S, but "rare" in the area between 28°S to 35°S. The frequency of occurrence was 8.8% in the oceanic zone, while it was 9.2% in the neritic zone. In the Great Barrier Reef region, it occurred inside the reef at 25% of 48 stations and the number of specimens throughout the whole collection was 3.4% of the total chaetognaths, while outside the reef the frequency of occurrence was 23% of 13 stations, and the percentage of specimens of this sagitta to the total chaetognaths was about 0.3%. Thus, Burfield states as follows :—"When present, this was fairly abundant inside the reef, but was very scarce outside. This is considered to be warm water form of the Indian and Pacific Oceans, and found from the surface to 50 m".

j) *The far oceanic waters of the Pacific, excluding the coastal waters along the continents, the Japanese and Philippine Islands and the Malay Archipelagoes* (Table 55).

During examination of a lot of plankton samples collected in the waters around the Palao Islands of the western Caroline Islands in 1940, I found *S. bedoti* in the material, but in only very small numbers. It appears to be distributed in the counter Equatorial Current, the South Equatorial Current, and the New Guinea Coastal Current, but rarely found in the North Equatorial Current and in the waters around the Palao Islands. In lagoons of the Palao Islands, this species was not found during my observation for eight months (1940–41). Later, I examined two other collections of chaetognaths from the equatorial region of the Pacific; a small series collected in 1953 near the Phoenix and the Gilbert Islands in the central Pacific, and the material collected in 1954 by the "Syunkotu-Maru" during her cruise to survey the after effects of a series of experiments with atomic and hydrogen bombs at Bikini Atoll. In both cases, I could not find any *S. bedoti*. Rose (1952) examined plankton samples from lagoons of the Tuamotu Islands, but found no *S. bedoti*. Both Hida's paper (1957) based on the material collected by the Pacific Oceanic Fishery Investigations of Hawaii in the middle North Pacific and Bieri's comprehensive report (1959)

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Near the Western Caroline Islands	Around the Palao Islands	North Equatorial Current		Counter Equatorial Current		South Equatorial Current	
Number of sampling stations	22	24		19		16	
* 1 - 5%	no data	—	0	1	7	2	9
* 6 - 10%		—		4		1	
* 11 - 15%		—		2		6	
* 16 - 20%		—	0	—	2	1	2
* 21 - 30%		—		1		—	
* 31 - 32%		—		1		1	
Occurrence	2	1		14		13	
Frequency of Occurrence	9%	4%		68%		88%	
* mean Percentage	+	+		13%		13%	

* Data obtained from the examination of 31 plankton samples hauled during the Oceanographic surveys of Palao～New Guinea in March～May 1940.

Table 55. Occurrence of *S. bedoti* in the material of Palao～New Guinea cruises.

based on the material from the Equapac and the Troll Expeditions and also other collections show that *S. bedoti* does not occur in the vast central area of the northern half of the Pacific.

k) *The Atlantic Ocean.*

The only record of *S. bedoti* from the Atlantic is presented by THIEL (1938) who recorded that only a single specimen of *S. bedoti* was found at Station 20 (50–100 m) near Cape Town during the German Meteor Expedition in the Atlantic Ocean. It is possible that *S. bedoti* might be carried into the Atlantic Ocean from the Indian Ocean by the southward Mozambique Current and then westward by the Agulhas Current along the southern coast of Africa, because this sagitta occurs near Port Natal as mentioned in section (h). This is very probable, because *S. neglecta* and *S. regularis*, both typical Indopacific warm water species, are also found in the Benguela Current off the west coast of the Union of South Africa, being carried there by the Agulhas Current (HEYDORN, 1959).

IV. The identity of *S. bedoti* from various localities.

One can be somewhat skeptical about the record of *S. bedoti* from the Atlantic Ocean, because it is not impossible that an imperfectly preserved immature specimen of *S. friderici* might be mistaken for *S. bedoti*. In some cases, the distinction between these two species can be made only on the presence (*bedoti*) or absence (*friderici*) of the rayless zones on the lateral fins. This character becomes easily obscured in some poorly preserved specimens.

Next, are the specimens of *S. bedoti* occurring in the eastern Pacific along the western coast of the equatorial Central and South Americas identical with those from the waters around the Philippines and Malay Archipelagoes? Examining closely the specimens from the eastern Pacific, I could affirm that they were quite identical with the so-called forma *minor* of *S. bedoti* found abundantly in the waters of the western tropical Pacific, as already shown in the section on taxonomic descriptions.

Lastly, are the specimens of *S. bedoti* from the Japanese waters identical with those found in the southern seas? For instance, THOMSON (1947) states that my records of *Sagitta bedoti* from the waters around Korea in 1940 might be erroneous, because they are much larger than those found in the southern seas. However, I believe they are truly *bedoti*. All characteristics, except for the body length, are quite common to specimens from both Japanese waters and the southern seas. The difference in body length is somewhat remarkable (30 mm to about 15 mm), but we find many other examples of such remarkable difference in body length. For instance, *Sagitta robusta* matures at 10 mm in the southern seas, but it reaches 21 mm in the water of somewhat low temperature in the Japan Sea; *S. enflata* is usually 15 mm or thereabout when mature, but it may attain 30 mm in the waters off Peru. Moreover, *S. bedoti* of the East China Sea and the Yellow Sea and that of the waters around the Malay Archipelagoes can be intermixed by the southward current in winter and the northward flow in summer through the South China Sea, although the strong influx of the North Equatorial Current seems to lower the density of this sagitta in this sea and lessen intermixing on a large scale. As far as concern the specimens examined by myself, there is not any doubt, I believe, that only a single species *S. bedoti* is here under consideration at present.

V. General account of the distribution of *S. bedoti*.

My acquaintance with *S. bedoti* gained through studies carried on at the Mitui Institute of Marine Biology near Simoda, Izu (1938), the observations made in the eastern part of the Inland Sea, namely Ôsaka Bay and Kii-Channel (1939), and the examination of the chaetognaths material from the waters arounnd western Japan (1940), and also through references accessible for me by that time, led me to believe that *S. bedoti* should be one of the common warm oceanic water species, probably being distributed in the Pacific as widely as many other warm water species. Hence, it appeared very strange to find that this sagitta was quite rare in the waters around the Palao Islands of the western Caroline Islands, when I examined, in 1940, a lot of planktsn samples hauled in this area. However, when I had finished the examination of chaetognaths collected from the central equatorial Pacific, extending from the Gilbert and Phoenix Islands to the Marshall Islands, I was aware of the possibility that the scantiness of *S. bedoti* in far oceanic water of the Pacific was not a temporal phenomenon but it is a distinct general feature. Consequently, I paid attention to the currents flowing in the western North Pacific and in the equatorial region, especially to the relation between the surface waters of the North Equatorial Current and the Kurosio. The Pacific coast of Japan is said to be washed by the Kurosio. Therefore, if the greater part of the surface water of the Kurosio were purely an extension of the North Equatorial Current, then *S. bedoti* would not appear abundantly along the Pacific coast of Japan. Furthermore, the contamination of the sea water by the fission products emitted by experiments at Bikini would be observed near the coast more frequently and in higher degree than it actually was. Of course, there could be water masses of somewhat coastal character along some parts of the Pacific coast of Japan and they may maintain *S. bedoti* and lessen the direct effect of the Kurosio. Moreover, there should be the lateral mixing of water along the left (west) side of the Kurosio, between it and the coastal water along the continent. This mixing might be carried on to a much larger scale than has been supposed. It is possible that *S. bedoti* may here be available as an indicator of the degree of this mixing in some parts of the Kurosio. To clear up these points, I started to collect data regarding the occurrence of *S. bedoti*, and to outline preliminarily the distribution of this species (TOKIOKA, 1957) from the plankton material collected by the Sôyô-Maru over a wide area extending from the northern Japan to the South China Sea. Now, with BIERI's comprehensive report (1959) on the distribution of chaetognaths in the Pacific together with personal observations on the large plankton collections present at Scripps Institution of Oceanography and with data from various other papers and personal communications all indicating an absence of *S. bedoti* in the mid Pacific, I believe the general features of the species can be discussed. Of course, the distribution will differ somewhat according to seasons. The differences are especially remarkable in the Indian Ocean and in some parts of the western Pacific, where the direction of currents may be quite changed with seasons. It is important to know if sampling stations and times were distributed evenly in a certain area, or to know whether or not this sagitta shows some peculiar vertical distribution. Concerning the latter point, so far as I am aware, this species can be considered an inhabitant of the surface water, probably above 100 m, most abundantly above 50 m. As to the seasonal variation in distribution and the even distribution of sampling stations and sampling times, I do not believe the data at hand are sufficient, but still I think they are sufficient to show the general outline of the distribution.

Sagitta bedoti is distributad widely in the Indian Ocean excluding the southern part of the ocean. In general, it is not abundant there, usually less than 10% of all chaetognaths, although it occurs commonly and abundantly in some embayments such as Bombay Harbour on the western coast and Lawson's Bay on the eastern coast of India. It occurs widely in the waters around the Malay Archipelagoes, but there also its percentage of the chaetognath fauna is usually less than 10%, excepting some cases in Boni Bay in the Flores Sea and in the Arafura Sea in some seasons. Most probably in the Indian Ocean and the waters around the Malay Archipelagoes, *S. bedoti* propagates in certain embayments or bays, out of which it drifts and is distributed widely in the ocean by the remarkable water movements found in these seas. As the currents vary remarkably in the Indian Ocean and around the Malay Archipelagoes depending upon season, the abundance of *S. bedoti* in these areas also fluctuates much according to season. At times waters-masses of somewhat coastal character and containing many *S. bedoti* may drift out into the central part of the Indian Ocean and give rise to the records of higher percentages in the middle of the ocean. The population of this species in the Arafura Sea is continuous with that along the eastern coast of Australia. Since there is no report indicating dense population of the species in the coastal waters of the eastern Australia, the population of this sagitta in certain portion of this area seems to be supplied in part from the Arafura Sea at least in the season when the currents in the Arafura Sea flow towards the east.

S. bedoti occurs in the South China Sea and in Philippine waters, but only infrequently and in very small numbers; for instance, in the Philippine waters it is recorded only from the Sulu Sea. Possibly this is due to the effect of the strong influx of the North Equatorial Current which is quite devoid of this sagitta. The species increases towards the north along the continent and attains a remarkably dense population (nearly 100% of all chaetognaths and also at a frequency of 100% in all plankton hauls) in the coastal part of the East China Sea and in the southern part of the Yellow Sea. It is usually absent in the south-eastern part of the East China Sea near Okinawa, where the northward extension of the North Equatorial Current flows. However, it appears in the north-eastern part of the sea, where the water of the East China Sea is conducted out by the strong flow of the Kurosio, and reaches a considerable density near the southern end of Kyûsyû Island. Its population near the southern end of Kyûsyû seems to fluctuate rather violently according to season and also according to hydrographical conditions changing from time to time. This species increases steadily in numbers from the western coast of Kyûsyû to the Korea Straits, where the waters of the East China Sea and the Yellow Sea are mixed in a considerable degree with the water of a branch of Kurosio, Tusima Current. In the Japan Sea it may constitute 100% of the chaetognath fauna at some stations along the boundary between the Liman and Tusima Currents. It also increases steadily in numbers along the Pacific coast of Honsyû, the mainland of Japan, and attains its maximum in the waters off the north-eastern part of Honsyû along the boundary between the Oyasio and the Kurosio. The distribution may extend eastwards to 161°39′ E; then it disappears completely in the vast area of the Pacific. Along the Pacific coast of Honsyû Island, this sagitta occurs commonly in the water mass on the coastal side of the Kurosio, but diminishes remarkably in the main stream of the Kurosio and disappears in the far oceanic water mass beyond the Kurosio. There, the Kurosio seems to constitute a barrier between the Japanese coastal water mass which is evidently populated by various organisms from the East China Sea, and the far oceanic water.

The species occurs in an isolated small area at the eastern-most part of the equatorial Pacific. It is quite absent in the North Equatorial Current, the Counter

Equatorial Current, and the South Equatorial Current along their long course to the western Caroline Islands, where it appears again in insignificant numbers in the North Equatoriol Current and increases in numbers towards the south. Probably *S. bedoti* is derived from the Sulu or Celebes Seas and carried eastward by the Mindanao Current and the Counter Equatorial Current. At first, I thought it possible that the population at the eastern-most part of the equatorial Pacific might be continuous with that in the south-eastern waters of Australia through the eastward current in the southern part of the South Pacific, but this is unlikely, because this sagitta decreases sharply at the southern stations in the Shellback area, quite disappears in the waters off Chile and at the offshore stations in the south-eastern waters of Australia.

VI. **Possible factors limiting the distribution of *S. bedoti.***

At a glance, *S. bedoti* might be considered as an inlet or bay-form since it occurs abundantly in Bombay Harbour and Lawson's Bay of India and in Boni Bay in the Flores Sea. However, there is a genuine inlet-water chaetognath in the Indian waters, namely *Sagitta bombayensis*. Also in the Japanese waters, the inlet-waters are populated by *S. crassa*, its forma *naikaiensis* and *Sagitta delicata*. *S. bedoti* is absent in the waters where these species are dominant. Along the Californian coast, the inlet-waters or lagoons are populated by *S. tenuis*. Thus, *S. bedoti* cannot be considered as an inlet-water form. Can it then be a coastal-water form? However the occurrence of the species in abundance in the central part of the Indian Ocean and in the far offshore waters along the boundary between the cold Oyasio and the the warm Kurosio in the western North Pacific, conflicts with this idea. Novertheless, it is an obvious fact that this species is distributed along the coasts in very many places of the Indo-Pacific. The ranges of temperature and salinity in the areas where *S. bedoti* occurs are surprisingly wide. For instance, SATYANARAYANA RAO and GANAPATI give 26.6–29.5°C for temperature and 20.79–34.16‰ for salinity in the Indian waters; SUND (1959c) gives 9–27°C for temperature and 27.9–34.8‰ for salinity in the upper 300 meters at all stations inspected where this species occurred during the Eastropic Expedition; the lowest salinity in my data is 30.95‰ in the surface and 31.89‰ in the deeper layer in the Korea Straits and the lowest temperature is 11.5°C in the Yellow Sea. Thus, it is evident that *S. bedoti* is euryhaline and eurythermal and this seems to support the idea that it is a coastal-water form or a form which is fond of the mixed water. As to the latter point, actually most of the coastal waters where *S. bedoti* occurs in high numbers are found near areas of mixing or the boundaries between different waters. In the Yellow Sea and the East China Sea, the far oceanic water of the western North Pacific and the coastal water of somewhat lower salinity are mixed. In the Japan Sea, the cold Liman Current and the warm Tusima Current mingle with each other. Off the North-Eastern part of Honsyû Island of Japan, the cold Oyasio and the warm Kurosio waters mix. In the eastern part of the equatorial Pacific, some upwelled water and the cold

Humboldt Current mingle with the tropical warm surface water. However, the biological conditions found in the mixing areas of different waters are favourable not only for *S. bedoti* but also for many other chaetognaths under certain circumstances; for instance in the Shellback area in the eastern equatorial Pacific many species of *Sagitta* thrive. On the other hand, in the central part of the Indian Ocean, where no remarkable mixing of different waters can be seen, a comparatively dense population of *S. bedoti* is maintained at least in some seasons. Why the same chaetognath which occurs in the central part of the Indian Ocean cannot survive in the mid Pacific Ocean is a moot question. The temperature-salinity relationships seem to be insufficient to explain the facts regarding this eurythermal and euryhaline chaetognath. Are there then some special chemical or biological factors (through food organisms, predators or competition) which differ between the Indian Ocean and the Pacific? So far as I am aware, there has not been as yet any definite answers to this question.

VII. "*Bedoti*-water".

Then, the following idea is considered possible that *S. bedoti* has specialized from a certain ancestor in the water mass which to-day contains this species in a considerable density and that the mixing of the water between this water mass and other water masses has been carried on in such a scale that the density of *S. bedoti* in the latter, dispersed there from the former, is always maintained below the lowest population level at which this sagitta can propagate. *S. bedoti*, when dispersed into far oceanic water might survive, but might be unable to reproduce below a certain population level, because self-fertilization is impossible. The lowest density at which the reproduction of the species can be maintained should differ specifically and it is conceivable that this limiting density might be comparatively high for *S. bedoti*. In other words, a comparatively high degree of stability can be expected in water masses containing *S. bedoti* in considerable numbers. In the East China Sea, the Yellow Sea and the middle part of the Japan Sea, the water is evidently moving, but it is considered to be circulating in a semi-closed system and thus considerable stability is maintained there. As regards propagation of various plankton organisms in areas of mixing, it is evident that a certain degree of stability of the mixed water is required for reproduction. Thus, it seems reasonable to separate the water masses containing *S. bedoti* from far oceanic water masses free from this species. It is proposed here to call the former "*bedoti*-water" because of this characteristic indicator. In the eastern Pacific, *S. friderici* shows a distribution somewhat like that of *S. bedoti* and actually occurs in the Shellback area together with *S. bedoti*. Besides these, *S. neodecipiens* and a peculiar form of *S. ferox* (f. *americana*) occur solely in this eastern *bedoti*-water. In the western North Pacific, the distribution of a calanoid copepod *Calanus lighti* is limited to far oceanic water and does not occur in the *bedoti*-water, some of the euphausids distributed widely in the western North Pacific seem to be slightly differentiated in some parts of the *bedoti*-water, the Japan Sea or in the East China Sea. All these facts seem to be attributable to the stability of the *bedoti*-water.

It might be possible to judge the grade of segregation of water-masses containing *S. bedoti* from the far oceanic water mass free from *S. bedoti* by measuring the density of this chaetognath. For instance, in the South China Sea, the low population of *S. bedoti* indicates a strong influx of the North Equatorial Current; near the southern coast of Kyûsyû, the Pacific coast of Honsyû and also in the Japan Sea the population of this species fluctuates considerably, probably according to the relative amount of influx of far oceanic water. In the Japan Sea, the average percentage of *S. bedoti* differs remarkably according to season, namely 30% in April, 16% in July and only 5% in September (1951–53). These data agree completely with the variation in strength of the Tusima Current and consequently the extent of far oceanic water.

As to the dense population of this chaetognath in the area of mixing between the Oyasio and the Kurosio off the north-eastern part of Honsyû of Japan, the distribution in this area cannot be considered as allogenetic one, but rather autogenetic distribution, because there occur very many young individuals (12 to 74%, 49% on an average in examined samples) referable to *S. bedoti*, and moreover it frequently constitutes 100% of the whole chaetognath population. Thus, the water in this area is considered to show a considerable degree of stability. I cannot judge whether this stability is attributable simply to the effect of SCHRÖDER's law applicable along the northern border of the Kurosio flowing eastwards or maintained by complex horizontal or vertical circulations; the questions will be answered by further works by hydrographers. At present, it is also unknown where the eastern distal end of this *bedoti*-water goes. It might extend towards the north east, where it is cooled below the critical temperature for *S. bedoti*, or it might be dispersed in the western North Pacific Central Water Mass below the limiting density required for propagation of this species. The wide distribution of *S. bedoti* in the Indian Ocean might be attributable partly to the smallness of this ocean itself or the existence of complex currents in this ocean.

7. THE FAR OCEANIC WATER OF THE CENTRAL NORTH PACIFIC

The remaining vast far oceanic water mass of the Pacific is divided into northern and southern halves by the Equatorial Currents. As to the possible differences in chaetognath fauna between these two halves and between the Western North Central Pacific and the Eastern North Central Pacific Water Masses, my data are less extensive than those of BIERI (1959), hence I shall not repeat any comments on this problem. However, I think it is useful to record here only the proportions between the four most commonly occurring species, mentioned below, in far oceanic waters and speculate as to the possibility of any constant differences in the chaetognath fauna between the above-mentioned divisions of the far oceanic waters. BIERI (1959) showed only the distribution of individual per unit volume of water for respective species in the Pacific. The various collections I have dealt with in this paper were collected by various kinds of gears and it is certain that even the same gear might not be used always in quite the same manner. However, the ratios among certain dominant species seem to be rather stable, because the effect of different gears and the manner in which they were used is minimized by this procedure. The errors which inevitably occur during the course of computing the individuals per unit volume of water might also be much reduced in this representation.

In Table 56, it is seen clearly that *S. enflata* is the commonest of the species collected in the warm oceanic waters of the North Pacific, next in order is *S. serratodentata pacifica*, *P. draco*, and *S. hexaptera*, as I previously noted on material from the waters around the Marshall Islands (1955). In the material of the Transpac Expedition, *S. minima* (F. O.*—39%, average percentage—30) and *S. regularis* (F. O.—26%, average percentage—9) were the important species; and in the Shellback material, *S. serratodentata tasmanica* (F. O.—98%, average percentage—8) occurred commonly and followed by *K. subtilis*, *K. pacifica*, *S. minima*, *S. regularis*, *S. lyra* and *S. decipiens*. Therefore, I calculated the three ratios *S. serratodentata pacifica*/*S. enflata* (S/E), *S. hexaptera*/*S. enflata* (H/E) and *P. draco*/*S. enflata* (P/E); and plotted the values of S/E in Figs. 29–31.

Before deducing any tendencies from the figures and tables, it is necessary to consider whether or not the greater part of the population of each of the above-mentioned four dominant species occurs in the surface water above 50 m. If it does not and if some of these species occur very abundantly in layers deeper than 50 m under some conditions or in some regions, then the comparison of ratios throughout the whole materials consisting of samples collected from various depths would be quite meaningless. Very fortunately, however, the dominant species, here selected, and also most of the common species in the warm water are concentrated in the upper 50 m layer, as mentioned by THIEL (1938) in the report of the German Atlantic Expedition by the "Meteor". HIDA (1957) mentions that "On Hugh M. Smith cruise 30 large catches, as number per unit of water strained, of Chaetognaths and Pteropods were taken in the shallow (0–40 m) hauls than in the deeper (0–140 m) hauls both during the day and at night". The tendency of chaetognaths to concentrate in the upper water seems to be as true in the Pacific as in the Atlantic. Hence, a comparison of ratios on world wide collections seems to be significant in a search for trends, although the values themselves in different samples collected from different depths cannot be estimated strictly on the same level. This point will be most pronounced in the case of *P. draco*, if this species is distributed in the Pacific in the same manner as in the Atlantic, where the centre of the distribution of this species is moved to the layer slightly deeper than in other three species.

The ratios calculated on the material from the Transpac Expedition, in which a small net (17 cm in diameter) was used and the catches were very small, fluctuate

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* F. O....Frequency of Occurrence

56	TP	J	MP	SB	EQP	P—N
Sag. hexaptera	80	—	**748**	**588**	**1300**	70
Sag. lyra	4	—	—	146	—	—
Sag. enflata	**644**	**828**	**1944**	**3300**	**4000**	**3395**
Sg. bipunctata	299	65	19	25	200	—
Sag. ferox	18	117	8	—	60	264
Sag. ferox f. *americana*	—	—	—	186	—	—
Sag. robusta	75	—	63	48	100	—
Sag. bedoti	204	**1008**	—	224	—	**897**
Sag. pulchra	—	—	*	78	40	49
Sag. friderici	16	—	—	50	—	—
Sag. pacifica	**2738**	**693**	**2520**	**2200**	**1700**	**1720**
Sag. tasmanica	1	—	—	**784**	—	—
Sag. pseudoserratodentata	45	—	112	34	20	—
Sag. neglecta	12	39	24	42	*	416
Sag. oceania	—	—	—	—	20	—
Sag. regularis	279	**1035**	14	134	200	**1806**
Sag. bedfordii	—	—	—	—	—	20
Sag. crassa f. *naikaiensis*	18	104	—	—	—	—
Sag. minima	**1200**	**1587**	154	192	*	—
Sag. decipiens	*	—	—	65	200	—
Sag. neodecipiens	—	—	—	23	—	—
Sag. planctonis	—	—	*	*	—	—
Sag. macrocephala	—	—	6	—	—	—
Pterosag. draco	**600**	—	**1470**	**864**	**1700**	**869**
Ktta. subtilis	28	—	105	276	80	3
Ktta. pacifica	217	—	11	162	80	240
Eukr. hamata	—	—	8	*	—	—
Damaged specimens or juv.	3420	4576	2047	600	900	264

Table 56. Occurrence of warm water species in respective materials (samples from inlet waters excluded).

Numbers indicate the value *Frequency of Occurrence×mean percentage* in respective species. *…less than 1, TP…Transpac Expedition material, J… material collected by a Japanese survey ship and presented to the party of the Transpac Expedition, MP…Midpac Expedition material, SB…Shellback Expedition material, EQP…Equapac Expedition material, P–N…Material of the Palao∼New Guinea cruises.

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layers	*S. enflata*	*S. hexaptera*	*S. serratodentata*	*Pterosag. draco*
0 - 50 m	26.8	5.6	42.6	4.57
50 - 100 m	7.2	4.68	12.94	7.0
100 - 200 m	1.05	1.36	4.0	1.4
200 - 400 m	0.75	0.2	1.2	0.2
400 - 600 m		0.02	0.08	0.05
600 - 800 m			0.07	0.01
800 - 1000 m			0.06	

Table 57. Vertical distribution of four important species in the Atlantic (Thiel, 1938).

rather violently, and consequently a comparison between these ratios and those of other catches collected by large nets from deeper waters is less significant. Here also, the efforts must be limited to seeking out trends. Throughout Figs. 29–31 and Tables 58–68, 70 and 73 the most remarkable trend may be noted in the distribution of the ratio between *S. serratodentata pacifica* and *S. enflata* (S/E).

a) **Distribution of S/E in collections examined** (Figs. 29–31, Tables 58–60).

The distribution of S/E shows a distinct tendency towards lower values in water masses inhabited by *S. bedoti* and higher in the *bedoti* free water masses. Generally speaking, in samples containing *S. bedoti* the values of S/E higher than 1.00 occur less frequently than the values lower than 1.00, while in samples containing no *S. bedoti* the values higher than 1.00 occur more frequently than the values lower than 1.00. The latter trend is, however, rather obscured in the Equapac Expedition material, the collection during the Palao-New Guinea cruises, and also in collections from the area within the distributional range of *S. bedoti*, such as the waters off north-eastern part of Japan and the Shellback area. Further, Fig. 29 shows that S/E is lower than 1.00 at most stations along the equatorial zone in the central Pacific, south of approximately 10°N. In other words, *S. enflata* is more abundant than *S. serratodentata pacifica* in the *bedoti*-water and also in the equatorial water mass in the far oceanic area of the Pacific, but decreases conspicuously and becomes less abundant than the latter in other parts of the far oceanic water of the Central North Pacific. The scarcity of *S. enflata* is epecially marked in the eastern half of the Central North Pacific, east of 180°, and most pronounced in the north eastern quarter of the Central North Pacific shown in Fig. 29, where *S. enflata* is nearly absent. Even *S. serratodentata pacifica* diminishes prominently there and the greater part of the chaetognath fauna consists of *S. minima*. Hida's paper (1957) on the chaetognath fauna in the central North Pacific also shows distinctly the scarcity of *S. enflata* throughout the subtropic and the transition zones extending from 145°W to 170°E. The boundary

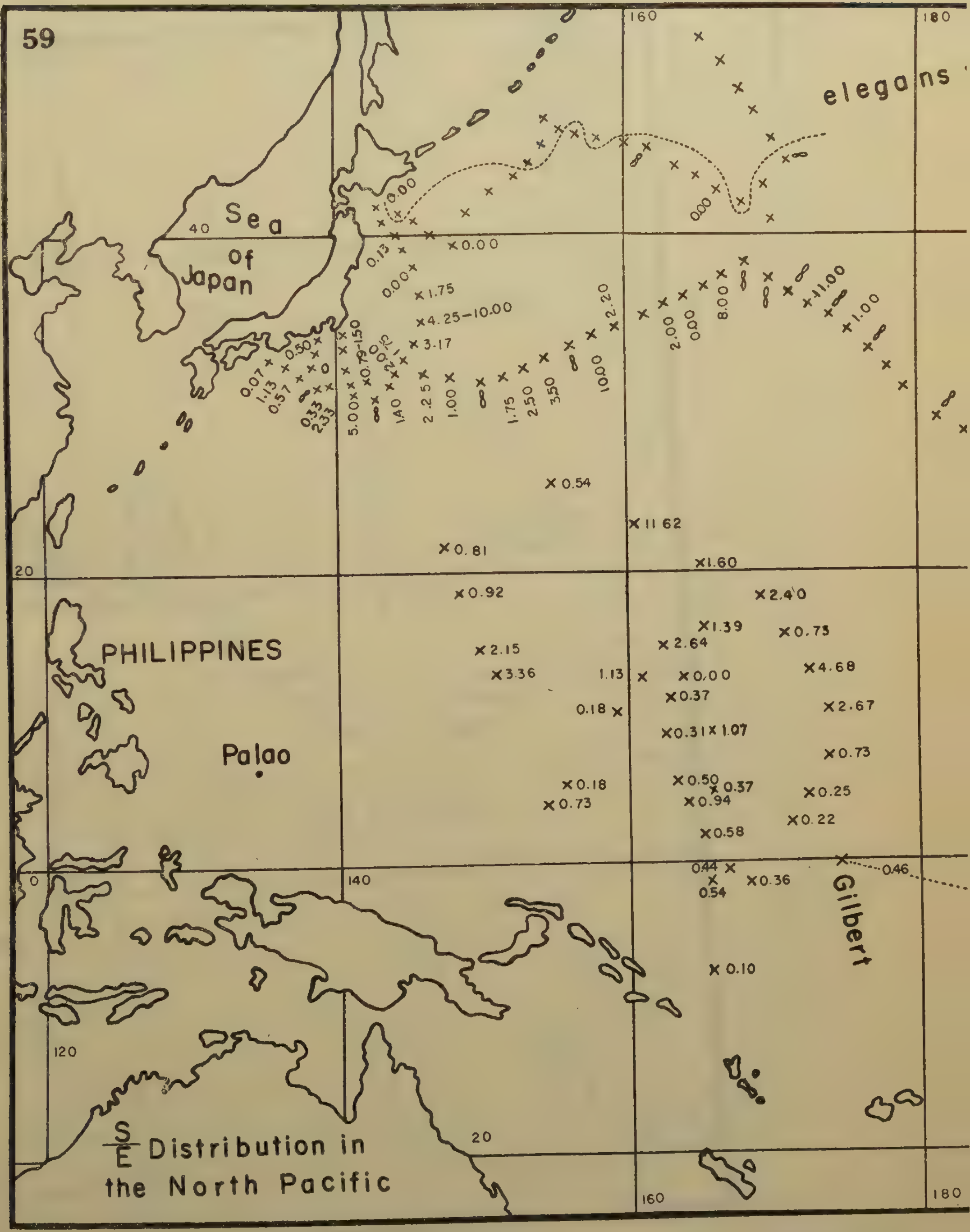

Fig. 29. Distribution of S/E in

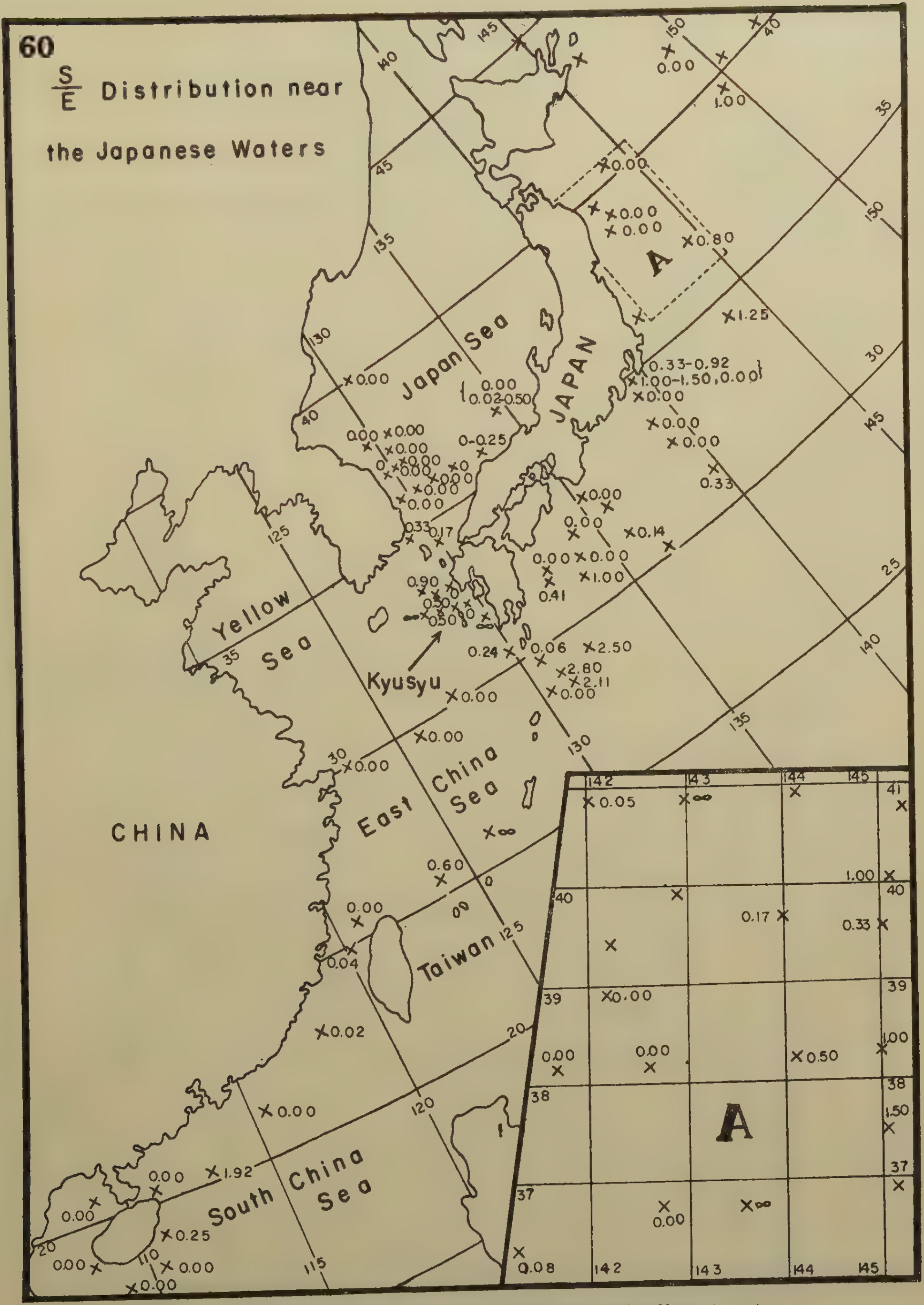

Fig. 30. Distribution of S/E in the Japanese and adjacent waters.

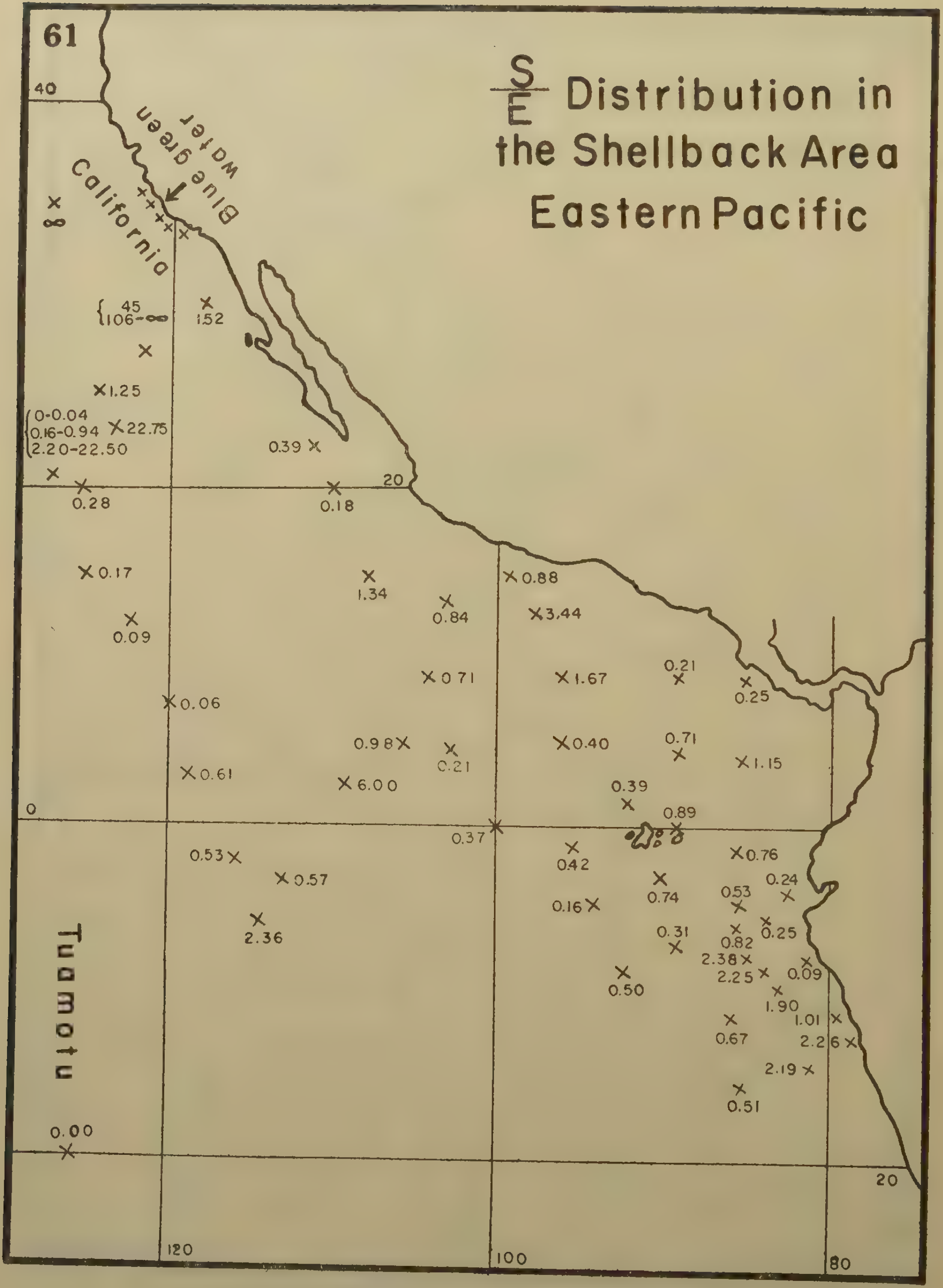

Fig. 31 Distribution of S/E in the Shellback area.

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	Japanese N.E. Waters			Transpac Exp.			Palao New Guinea			Shellback Exp.			total		
	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E
%	3	2	3	2	1	2							5	3	5
0	7	2	7	7	3	4	18	2	1	1		1	33	7	13
* —0.10		2			1	1	1	1	1	8	1	6	9	5	8
0.11 — 0.50		2			1	2	1	9	14	15	12	13	16	24	29
0.51 — 1.00		1			1			4	3	3	11	7	3	17	10
1.01 — 2.00					1			3			2			6	
2.01 — 5.00									1		1			1	1
5.01 — 10.00															
> 10.01								1						1	
∞ (enflata 0)		1			1									2	
Number of samples	10			9			20			27			66		

	H/E	S/E	P/E
0	38	10	18
* - 1.00	28	46	47
1.01 - ∞	0	10	1

Table 58. Occurrence of respective values of H/E, S/E and P/E in samples collected in the *bedoti*-water mass in materials examined. *···present, but less than 1%.

59

	Transpac Exp. incl. Stranger's samp.			Midpac Exp.			Shellback Exp.		
	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E
0/0	15	7	14	6	6	6			
0				11	2	10			1
* — 0.10				6	5	3	9	2	6
0.11 — 0.50				11	6	7	8	4	12
0.51 — 1.00				3	5	5	2	4	1
1.01 — 2.00				5	3	5	2	4	1
2.01 — 5.00				4	11	7		5	
5.01 — 10.00				1	3	2		1	
> 10.01					5	2		1	
∞ (enflata 0)	1	9	2	4	5	4			
Number of samples	16			51			21		

0	15	7	14	17	8	16			1
* — 1.00				20	16	15	19	10	19
1.01 — ∞	1	9	2	14	27	20	2	11	1

Table 59. Occurrence of respective values of H/E, S/E and P/E in samples collected in the *bedoti*-free water mass in the eastern half of the North Pacific in materials examined (east of 160°W). *···present, but less than 1%.

between the *bedoti*-water and the far oceanic water showing higher S/E and that between the latter and the equatorial water mass showing lower S/E are defined rather distinctly, but the distribution of S/E in other parts of the far oceanic water in the Central North Pacific does not show any clear discontinuous lines as far as the collections examined are concerned, although the above-mentioned trends are discernible.

b) Distribution of S/E in other parts of the Indo-Pacific based on available data.

i) *Near the Japanese waters.* In Tables 61–63 and 73 B are given values of S/E calculated from the following material: Sôyô-Maru (TOKIOKA, 1957); western Japan

60	Palao New Guinea			Japanese N.E. Waters			Transpac Exp.			Midpac Exp.			Equapac Exp.		
	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E
0/0	1		1	2	1	2	21	5	14						
0	6	2	4	4	1	4	24	3	12						
* — 0.10	1	1	1						1					1	
0.11 — 0.50	1	2	2		1		3	2	8	3		1	4	2	4
0.51 — 1.00		1			1			3	3	1		4	1	1	1
1.01 — 2.00		2	1		1		2	7	2	1	1			1	
2.01 — 5.00								10	3		4				
5.01 — 10.00								3							
> 10.01								1							
∞ (enflata 0)		1			1		2	18	9						
Number of samples	9			6			52			5			5		

0	7	2	5	6	2	6	45	8	26						
* — 1.00	2	4	3		2		3	5	12	4		5	5	4	5
1.01— ∞		3	1		2		4	39	14	1	5			1	

Table 60. Occurrence of respective values of H/E, S/E and P/E in samples collected in the *bedoti*-free water masses in the western half of the North Pacific in materials examined (west of 160°W). *···present, but less than 1%

(TOKIOKA, 1940) ; Kii-Channel connecting the eastern end of the Inland Sea with the open sea (MURAKAMI, 1959) ; small collection from the Japan Sea (FURUHASHI, 1953) ; New Yamato Bank in the Japan Sea (TOKIOKA, 1951) ; Sagami and Suruga Bays from May 1936 to April 1937 (TOKIOKA, 1954) ; and a dense patch of chaetognaths that appeared near the Seto Marine Biological Laboratory on Feb. 25, 1954 (TOKIOKA, 1954) ; together with some fragmentary data.

Tôkyô Bay—According to MURAKAMI's data (1959), in the 44 samples collected from the mouth of the bay, the following frequencies prevailed—*S. enflata* 47%, *S. hexaptera* 14%, *S. serratodentata pacifica* 5%, and *P. draco* 9%. The water of this region is evidently *bedoti*-water as mentioned previously (Frequency of Occurrence of *S. bedoti*—47%), and S/E is apparently lower than 1.00. *S. hexaptera* occurred in six samples, in the two of these the species exceeded *S. enflata* as 1:0 and 5:2.

61 SÔYÔ MARU 1934 1937—39	N.E. Japan (B) north to 40°N			*N.E. Japan (B) south to 40°N			South Western Honsyu						Sagami Bay bedoti water			Japan Sea Furuhashi 1953			*N.Y. B.
							bedoti water			no bedoti									
	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	S/E
%	4	4	4	2	2	2	1	2	2							2	2	1	
0	2	2	2	2	2	5	7	6	8		1	1	3	2	2	2	1	2	
* — 0.10				1			1						1		1				4
0.11 — 0.50				1			1	3	2	1			2	1	3				4
0.51 — 1.00				1	2			1						2			1		
1.01 — 2.00					1									1					
2.01 — 5.00							1												
5.01 — 10.00																			
> 10.01																			
∞ (enflata 0)							1											1	
Number of samples	6			7			12			1			6			4			8

* N.E.---- North Eastern
(B)----- bedoti water

*--- NewYamato Bank in the Japan Sea

0	6	6	6	4	4	7	8	8	10		1	1	3	2	2	4	3	3	
* — 1.00				3	2		2	4	2	1			3	3	4		1		8
1.01 — ∞					1		2							1				1	

Table 61. Occurrence of respective values of H/E, S/E and P/E in plankton samples collected in the Japanese waters (1). *···present, but less than 1%.

SÔYÔ MARU 1934 1937—39 **62**	Waters off the Southern Kyusyu						East China Sea						South China Sea					
	bedoti water			no bedoti			bedoti water			no bedoti			bedoti water			no bedoti		
%	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E
0/0										1		1						
0	2	1	4	1		2	2	2	2	1		1	5	3	6	3	3	3
* — 0.10		1												1				
0.11 — 0.50	1	1		1									1	1				
0.51 — 1.00	1										1							
1.01 — 2.00														1				
2.01 — 5.00		1			2													
5.01 — 10.00																		
> 10.01																		
∞ (enflata 0)											1							
Number of samples	4			2			2			2			6			3		

0	2	1	4	1		2	2	2	2	2		2	5	3	6	3	3	3
* — 1.00	2	2		1							1		1	2				
1.01 — ∞		1			2						1			1				

Table 62. Occurrence of respective values of H/E, S/E and P/E in plankton samples collected in the Japanese waters (2). *····present, but less than 1%.

63

TOKIOKA 1940	Waters off the Western Kyusyu						Waters off the Southern Kyusyu						Kii Suidô (Murakami '59)					
	bedoti water			no bedoti			bedoti water			no bedoti			bedoti water			no bedoti		
	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E
0/0	4	1	3				1	1	1				22	22	21	27	26	27
0	2	2	2				8	6	8	3	3	2	100	44	53	37	26	28
* — 0.10	1								3			2		46	42		7	5
0.11 — 0.50	1	1	2	1		1	3	3		1	1			6	3		1	3
0.51 — 1.00		1			1			1						1	1		1	1
1.01 — 2.00								1						3	1			
2.01 — 5.00																	1	
5.01 — 10.00																	1	
> 10.01																		
∞ (enflata 0)		3	1												1		1	
Number of samples	8			1			12			4			122			64		

0	6	3	5				9	7	9	3	3	2	122	66	74	64	52	55
* — 1.00	2	2	2	1	1	1	3	4	3	1	1	2		53	46		9	9
1.01 — ∞		3	1					1						3	2		3	

Table 63. Occurrence of respective values of H/E, S/E and P/E in plankton samples collected in the Japanese waters (3). *···present, but less than 1%.

Bungo Channel—This is the channel connecting the south-western end of the Inland Sea and the open sea. Twelve samples were examined by MURAKAMI (1959). *S. enflata* occurred in four of them, but no *S. serratodentata pacifica*, *S. hexaptera*, nor *P. draco* were found in the material. This region is a mixing area between the *crassa*-water of the Inland Sea and the *bedoti*-water off south-western Honsyu.

The Japan Sea—In 32 samples treated by TOKIOKA (1940), *S. enflata* occurred at a frequency of 30%, while *S. hexaptera*, *S. serratodentata pacifica* and *P. draco* were quite absent. Of the material from the waters near the New Yamato Bank (TOKIOKA, 1951), only S/E of the vertical hauls are shown in Table 61. *S. hexaptera* was not found in the vertical hauls and only two specimens of *P. draco* occurred in a single sample. On the other hand, 13 of the 66 surface hauls contained *S. enflata*, but no *S, hexaptera*, *S. serratodentata pacifica* nor *P. draco* were represented in the material. The surface water of this region is evidently *bedoti*-water, but the water in deeper layers is mixed with *elegans*-water as in the region where FURUHASHI (1953) collected his samples (36°05.2′ N–36°32′ N×133°39.0′ E–135°41.5′ E). In these waters *S. minima* was very abundant as mentioned previously (p. 404). In 32 samples collected in the *crassa* or *bedoti*-water of the Korea Straits (TOKIOKA, 1940), *S. enflata* occurred at a frequency of 63% and *S. serratodentata pacifica* at a frequency of 6%, while both *S. hexaptera* and *P. draco* were absent.

The Yellow Sea—In twenty-six samples examind (TOKIOKA, 1940), no *S. enflata*, *S. hexaptera*, *S. serratodentata pacifica* nor *P. draco* were detected.

The East China Sea—In twelve samples collected in the characteristic *bedoti*-water near the Chu San Islands (TOKIOKA, 1940), *S. enflata* occurred at a frequency of 42%, but *S. hexaptera*, *S. serratodentata pacifica* or *P. draco* were quite absent.

All these data appear to indicate a tendency of *S. enflata* to be abundant while *S. serratodentata pacifica* is very scarce within the range of the distribution of *S. bedoti*, and this does not regard the presence or absence of *S. bedoti* in respective samples. However, in the areas where the *bedoti*-water is adjacent to far oceanic water or is mixing with the latter, some masses of various sizes of far oceanic water may be carried into the *bedoti*-water in various degree and consequently remarkably high values of S/E are sometimes met with as is shown in the case of the dense chaetognath patch that appeared at Seto.

ii) *The South China Sea and the Philippine waters* (Tables 62, 64 and 66). In the samples collected near Hainan Island (Table 62), S/E is lower than 1.00 in most cases. The value should be also very low near Nhatrang-Cauda, Viet Nam, because HAMON (1956) gives the following data: (A) In 58 samples···*S. enflata*—2644 individuals in the material, and occurred at a frequency of 59%; *S. hexaptera* did not occur in the material; *S. serratodentata pacifica*—only 4 individuals in the material, and occurred at a frequency of 2%; and *P. draco*—only 2 in the material, and occurred at a frequency of 2%. (B) In 17 samples collected by Dr. M. RANSON ···*S. enflata*—7796 individuals in the material, and occurred at a frequency of 100%;

64 Sn SNELLIUS Sb SIBOGA	Sulu Sea (Sn)						Sulu Sea (Sb)						Celebes Sea (Sn)					
	bedoti water			no bedoti			bedoti water			no bedoti			bedoti water			no bedoti		
	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E
0/0				1	1	1										14	11	13
0	6	1	6	4	1	4		1	1	1	1		35	3	17	21	7	19
* — 0.10		3	2				2	1	1			1	3	6	15		4	3
0.11 — 0.50		1			1								3	9	6	1	5	2
0.51 — 1.00	1	1												14	5	1	2	
1.01 — 2.00	1	2											1	5		1	2	
2.01 — 5.00					2								1	5	1		2	
5.01 — 10.00													1					
> 10.01														2			2	
∞ (enflata 0)																	3	1
Number of samples	8			5			2			1			44			38		

0	6	1	6	5	2	5		1	1	1	1		35	3	17	35	18	32
* — 1.00	1	5	2		1		2	1	1			1	6	29	26	2	11	5
1.01 — ∞	1	2			2								3	12	1	1	9	1

Table 64. Occurrence of respective values of H/E, S/E and P/E in plankton samples hauled in the waters around the Malay Archipelagoes (1). *···present, but less than 1%.

65

Sn SNELLIUS

Sb SIBOGA

	Celebes Sea (Sb)			Java Sea (Sn)						Flores Sea (Sn)					
	bedoti water			bedoti water			no bedoti			bedoti water			no bedoti		
	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E
%				1	1	1	4	1	3	1	1	1	6	5	6
0	2		3	20	2	7	13	7	10	40	6	27	24	11	17
* —— 0.10	1	2	1	2	8	13	1	3		8	19	10		1	
0.11 —— 0.50		2			7	4		1	3	4	9	13		5	6
0.51 —— 1.00	1			2	5			3	1		6	1		4	
1.01 —— 2.00					2				1		4			2	1
2.01 —— 5.00								1			5	1			
5.01 —— 10.00															
> 10.01											3			1	
∞ (enflata 0)								2						1	
Number of samples	4			25			18			53			30		

0	2		3	21	3	8	17	8	13	41	7	28	30	16	23
* —— 1.00	2	4	1	4	20	17	1	7	4	12	34	24		10	6
1.01 —— ∞					2			3	1		12	1		4	1

Table 65. Occurrence of respective values of H/E, S/E and P/E in plankton samples hauled in the water around the Malay Archipelagoes (2). *…present, but less than 1%.

66 Sn SNELLIUS Sb SIBOGA	Moluccas Arch. (Sn)						Moluccas Arch. (Sb)						East South off Mindanao(Sn)					
	bedoti water			no bedoti			bedoti water			no bedoti			bedoti water			no bedoti		
	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E
0/0	1	1	1	10	2	7										11	4	12
0	36	5	15	24	6	17	4		2	1	1	1	10		10	16	3	14
* —— 0.10	6	18	16		2	1	9	11	9	1		1		3	1		3	2
0.11 —— 0.50	4	14	15	1	8	4	1	3	3				1	3	3		1	1
0.51 —— 1.00	3	2	2		1	2					1			3		1	3	1
1.01 —— 2.00		4	1		2								1	1		1	1	
2.01 —— 5.00		5			1	1							1	1		1	3	
5.01 ——10.00					3								1	2			4	
> 10.01		1			2									1			1	
∞ (enflata 0)					8	3											7	
Number of samples	50			35			14			2			14			30		

0	37	6	16	34	8	24	4		2	1	1	1	10		10	27	7	26
* —— 1.00	13	34	33	1	11	7	10	14	12	1	1	1	1	9	4	1	7	4
1.01 —— ∞		10	1		16	4							3	5		2	16	

Table 66. Occurrence of respective values of H/E, S/E and P/E in plankton samples hauled in the waters around the Malay Archipelagoes (3). *···present, but less than 1%.

67

Sn SNELLIUS Sb SIBOGA	Boni Bay (Sn)						Banda Sea (Sn)						Banda Sea (Sb)					
	bedoti water			no bedoti			bedoti water			no bedoti			bedoti water			no bedoti		
	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E
%	1	1	1	1	1	1	3	1	2	9	4	9						[illegible]
0	3		1	1	1	1	63	10	36	28	9	23	2		1			1
* —— 0.10		4	3				9	22	21		2	1	1	2	1	1	-	
0.11 —— 0.50	1						4	23	15		5	2						
0.51 —— 1.00							2	9	5	1	3	1			1			
1.01 —— 2.00								8	2		5	1		1			1	
2.01 —— 5.00							1	7			3							
5.01 —— 10.00											1							
> 10.01											1	1						
∞ (enflata 0)								2	1		5							
Number of samples	5			2			82			38			3			1		

0	4	1	2	2	2	2	66	11	38	37	13	32	2		1			1
* —— 1.00	1	4	3				15	54	41	1	10	4	1	2	2	1		
1.01 —— ∞							1	17	3		15	2		1			1	

Table 67. Occurrence of respective values of H/E, S/E and P/E in plankton samples hauled in the waters around the Malay Archipelagoes (4). *···present, but less than 1%.

SNELLIUS 68	Arafura Sea						Timor Sea						Savu Sea					
	bedoti water			no bedoti			bedoti water			no bedoti			bedoti water			no bedoti		
	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E
%				4		4										6	3	6
0	10	2	8	10	7	8	7		3	3	1	3	10	3	4	5	4	5
* — 0.10	1	6	6		1		2	5	5					3	3			
0.11 — 0.50	3	2			1	1		2	1				2	3	6			
0.51 — 1.00		1						1			1		1	2				
1.01 — 2.00		1			1			1						2				
2.01 — 5.00		1				1					1							
5.01 — 10.00		1															1	
> 10.01																		
∞ (enflata 0)					4												3	
Number of samples	14			14			9			3			13			11		

0	10	2	8	14	7	12	7		3	3	1	3	10	3	4	11	7	11
* — 1.00	4	9	6		2	1	2	8	6		1		3	8	9			
1.01 — ∞		3			5			1			1			2			4	

Table 68. Occurrence of respective values of H/E, S/E and P/E in plankton samples hauled in the waters around the Malay Arhipelagoes (5). *···present, but less than 1%.

S, *hexaptera* did not occur in the material ; S. *serratodentata pacifica*—18 individuals in the material, and occurred at a frequency of 18% ; and *P. draco* did not occur in the material.

During the Albatross Expedition in the Philippine waters, chaetognaths were collected at 46 stations in the area extending 5°36′–21°31′ N×117°53′–127°44′ E. In this material, the four species under consideration occurred in the following proportion (MICHAEL, 1919) : *S. enflata*—2800 individuals in the material, and occurred at a frequency of 85% ; *S. hexaptera*—700 individuals in the material, and occurred at a frequency of 57% ; *S. serratodentata*—100 individuals in the material, and occurred at a frequency of 15% ; and *P. draco*—22 individuals in the material, and occurred at a frequency of 11%. It is evident that S/E must be very low in the Philippine waters.

iii) *The waters around the Malay Archipelagoes* (Tables 64–69 and 73 B). Many data from this area are divided into two groups, namely those from samples collected in the *bedoti*-water masses and those hauled in the water masses containing no *S. bedoti*. Throughout the Tables 64–68 and 73 B, it is easily noted that higher

69	*bedoti* water mass	non *bedoti*-water mass	
Sulu Sea (Sn.)	3.00	1.50	○
Sulu Sea (Sb.)	∞	∞	
Celebes S. (Sn.)	2.67	3.22	×
Celebes S. (Sb.)	∞	—	
Moluccas Arch. (Sn.)	4.00	1.19	○
Moluccas Arch. (Sb.)	∞	∞	
East south off Mindanao	1.80	0.88	○
Java Sea	11.50	5.00	○
Flores Sea	3.42	6.50	×
Boni Bay	∞	∞	
Banda Sea (Sn.)	3.82	1.53	○
Banda Sea (Sb.)	2.00	0.00	○
Arafura Sea	3.67	1.80	○
Timor Sea	8.00	2.00	○
Savu Sea	5.50	1.75	○

Table 69. The value of S/E lower than 1.00/ S/E higher than 1.00 in various parts of the waters around the Malay Archipelagoes.

○···the value higher in *bedoti*-water than in non-*bedoti*-water.
×···the value higher in non-bedoti-water than in *bedoti*-water.

70

	Central Indian Ocean						off Somaliland						near Aden			Red Sea		
	bedoti water			no bedoti			bedoti water			no bedoti			bedoti water			no bedoti		
	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E
0/0										1	1	1						
0	5		1	3		4	10	6	9	20	14	19		2	2	6	6	6
* —— 0.10	8		4				1	1	2		2	1	2					1
0.11 —— 0.50	6	1	12					2	1	1	2	1					1	
0.51 —— 1.00	1	8	3	1	4		2	2			2							
1.01 —— 2.00		3						1	1		1					1		
2.01 —— 5.00		8						1										
5.01 —— 10.00																		
> 10.01																		
∞ (enflata 0)																		
Number of samples	20			4			13			22			2			7		

0	5		1	3		4	10	6	9	21	15	20		2	2	6	6	6
* —— 1.00	15	9	19	1	4		3	5	3	1	6	2	2				1	1
1.01 —— ∞		11						2	1		1					1		

Table 70. Occurrence of respective values of H/E, S/E and P/E in plankton samples collected in the Indian Ocean and the adjacent waters. *···present, but less than 1%.

values of S/E seem to occur more frequently in the non-*bedoti*-water masses than in the *bedoti*-water masses. The value $\frac{\text{S/E lower than 1.00}}{\text{S/E higher than 1.00}}$ in various parts of the waters around the Malay Archipelagoes are given in Table 69. OYE (1918) examined samples collected at 77 stations in the Java Sea and showed the proportion of the four species as follows: *S. enflata* occurred at a frequency of 97% and constituted 31% of the whole collection of chaetognaths, *S. hexaptera* occurred at a frequency of 64% and constituted 5% of the whole collection of chaetognaths, while *S. serratodentata* did not occur and *P. draco* occurred at a frequency of only 1%. He states that the absence of *S. serratodentata* in the material is a result of only surface towing, while the species is probably a mesoplanktonic form. This is, however, not likely, because most samples of the Snellius material were also collected in the surface layer and yet they comprised a considerable number of *S. serratodentata*. However, his data can be safely accepted in support of the tendency of *S. serratodentata* to be very scarce in this area of *bedoti*-water as compared to the far oceanic waters. In 55 samples from the Arafura and Timor Seas, examined by TOKIOKA (1955b), *S. serratodentata pacifica* and *P. draco* were extremely scarce and *S. hexaptera* was quite absent. The water of the Arafura Sea was of the typical *bedoti*-water at that time.

iv) *The Indian Ocean* (Tables 70 and 73 B). Besides the data on the material from the central Indian Ocean (TOKIOKA, 1956), the material collected by the "Cherso" from the Red Sea and from the waters along Somaliland (GHIRARDELLI, 1948) and a small collection from the North Eastern part of the Ocean (Nicobar, Nias and Bali-Lombok) shown in Tables 70 and 73 B, there are the following fragmentary data:—

In a single sample collected near Ceylon (TOKIOKA, 1956), H/E was 0, S/E 6.5 and P/E was 2.5. In a single sample hauled in the Red Sea (300–0 m, in April 1929) by the Snellius (SCHILP, 1941), H/E was 4.6, S/E 0.4 and P/E was 0. It is somewhat strange that S/E is rather high even in the *bedoti*-water mass in the central part of the Indian Ocean. Since *S. serratodentata pacifica* can be used as an indicator of oceanic water in the waters off Visakhapatnam near Waltair (S. RAO and GANAPATI, 1958, p. 167) and BURFIELD (1926) shows that *S. serratodentata* is most abundant in the surface layer of this ocean, the above-mentioned phenomenon might indicate that the water of the surveyed area in the central Indian Ocean still retains in considerable degree, the characteristics of far oceanic water in spite of the existence of *S. bedoti*.

v) *Along the Eastern coast of Australia* (Tables 71–72). THOMSON (1947) gives the frequency of occurrence of the four species in the waters of south-eastern Australia as in Table 71. The rate of increase in the oceanic water is much higher in *S. pacifica* than in *S. enflata*, but probably *S. enflata* is more abundant than *S. pacifica* in both neritic and oceanic waters. BURFIELD (1950) shows the proportion of the four species

71 F.O.	at 161 neritic stations over the continent shelf	at 113 oceanic stations beyond the continent shelf
Sag. enflata	51.5%	54.0%
Sag. hexaptera	22.4%	58.4%
Sag. pacifica	31.6%	46.0%
Pterosag. draco	30.4%	62.8%

Table 71. Distribution of four important species in the waters of the South-Eastern Australia (THOMSON, 1947).

72	inside the reefs	outside the reefs
Sag. enflata	110728 ind.	14735 ind.
Sag. hexaptera	243	837
Sag. pacifica	3	64
Pterosag. draco	5	74

Table 72. Distribution of four important species in the Great Barrier Reef region (BURFIELD, 1950).

in the Great Barrier Reef region as above: S/E is clearly higher in the waters outside the reefs, althoug the dominancy of *S. enflata* is still retained there. Both of these surveyed areas belong to *bedoti*-water.

vi) *Central part of the Pacific* (Table 72 A and B). The material of the Syunkotu-Maru (TOKIOKA, 1954) indicates distinctly that S/E is higher in the North Equatorial Current than in the Counter Equatorial and South Equatiorial Currents. S/E is also lower than 1.00 in the material collected near the Phoenix and Gilbert Islands.

vii) *Off Chile* (Table 73 A). FAGETTI (1958) examined 220 samples collected from the waters off north and middle Chile. In her material, *S. hexaptera* occurred only once and *P. draco* did only five times, while *S. pacifica* occurred at a frequency of 36%. S/E seems to vary from time to time, but the dominancy of *S. enflata* was maintained throughout the whole material.

All of the data, quoted here, indicates that *S. enflata* is very rich in the *bedoti*-water, while *S. serratodentata pacifica* increases towards the offshore oceanic waters and the S/E becomes higher in the far oceanic water, excepting the area along the equatorial zone. The influx of the North Equatorial Current retaining higher S/E flows into the waters around the Malay Archipelagoes, and consequently the values of S/E higher than 1.00 occur rather frequently in this area. The dominance of *S. enflata* in the Shellback area is maintained also in the waters off north to middle Chile, although the frequency of occurrence of S/E higher than 1.00 seems to be higher in the latter to some extent.

73 A

	Syunkotu maru 1954									off Chile			S/E
	N.Eq. Current			Count.Eq.Curr.			S.Eq.Current						
%	H/E	S/E	P/E	H/E	S/E	P/E	H/E	S/E	P/E	'54 Aug.	'54 Dec.	'55 Mar.	'56 Jun.
0	1	1	1							5	2	4	6
* —— 0.10	1		1	2			4		2	1		3	5
0.11 —— 0.50	4	2	3	4	4	6		3	2	8	8	7	7
0.51 —— 1.00	5	4	5		3	1		1		6	4	2	1
1.01 —— 2.00	3	3	5	1						1	4		3
2.01 —— 5.00	2	6	2								5	2	1
5.01 —— 10.00	1									1	1		
> 10.01		1										2	1
∞ (enflata 0)										1	1	2	2
Number of samples	17			7			4			23	25	22	26

0	1	1	1							5	2	4	6
* —— 1.00	10	6	9	6	7	7	4	4	4	15	12	12	13
1.01 —— ∞	6	10	7	1						3	11	6	7

B

	H/E	S/E	P/E	
Java Sea (Siboga)	0.22	0.07	0	B
Nicobar (Tokioka'55)	0.10	0.30	0.90	B
Nias (Tok.'55)	0.12	1.12	1.00	B
Bali Lombok (Tok.'55)	0.05	0.58	0.49	B
Phoenix Gilbert (Tok.'54)	0.07	0.46	0.08	n.B
Sagami Bay (Tok.'54)	0.02	0.57	0.13	B 16 %
Dense patch at Seto (Tok.'54)	0.02	11.06	2.97	B < 1%

B	Sag. bedoti present
n.B	no bedoti

Table 73. Occurrence of respective values of H/E, S/E and P/E in plankton samples came from various parts of the Pacific. *···present, but less than 1%.

c) Distribution of H/E.

As the number of specimens of S. *hexaptera* collected during the Transpac Expedition with a small net from the surface water above 50 m is very small, it is quite imposiible to establish any trends in the distribution of this species from the data of this expedition. As shown in Table 57 indicating the results of the German Atlantic Expedition by the "Meteor" the population of S. *hexaptera* is relatively large in deeper layers as compared with those of S *enflata* and S. *serratodentata.* For instance, let us compare the two columns of Appendix Table 1 No. 4, which show the chaetognath populations of the two samples collected at the same station respectively by a small net from 50 m to surface and by a large net from 450 m to the surface. In the sample of *TP 131 from the deeper water, a considerable number of S. *hexaptera* were found and actually the number was larger than that of S. *enflata.* But the animals seem to easily avoid being caught when a smaller net is used or when the haul is limited to the surface layer. The same phenomena are seen also in the results of the Snellius Expedition, in which S. *hexaptera* occurred commonly in samples collected from the deep waters, but very scarcely in those collected by towing a small net in the surface water.

However, in examining the tables and data given in the preceding section (b, i–vii), it may be safely said that S. *hexaptera* shows a tendency to decrease in the *bedoti*-water and the adjacent waters, while increasing in the offshore far oceanic waters. The distribution of this species in a part of the far oceanic water of the Central North Pacific is shown by HIDA (1957), who illustrates very distinctly that the species is one of the most important chaetognaths in the subtropic and the transition zones between meridians 145°W–170°E and consequently H/E is enormously large in this area. TOKIOKA (1955) also stated that the proportion of S. *hexaptera* increases towards the north in a limited area in the central Pacific, covering the North Equatorial Current, the Counter Equatorial Current and a part of the South Equatorial Current. The raise of H/E towards the north in far oceanic waters cannot be considered to result only from the decrease of S. *enflata*; it can result by actual increase of S. *hexaptera.*

Looking through Tables 64–68 and 73 B, showing the proportional abundance of the four species near the Malay Archipelagoes, S. *hexaptera* and P. *draco* seem superficially to occur more frequently and abundantly in the *bedoti*-water masses than in the non-bedoti-water masses. But, this is rather questionable, because most of the larger samples collected from the deep waters are included in the column of the *bedoti*-water. And it is evident that the frequency of occurrence of S. *hexaptera* and P. *draco* is much higher in the larger samples from deep waters than in smaller samples collected by towing in the surface water, and the same applies to S. *bedoti.* Hence, the occurrence of the first two species together with S. *bedoti* should be more frequent than those two species alone in the region within the range of the distribution of S. *bedoti.*

d) Distribution of P/E.

The distribution of *P. draco* in the *bedoti*-water resembles that of *S. hexaptera*; it is rather scarce there, but increases considerably in far oceanic waters. In the far oceanic water of the Central North Pacific, the population of this species is larger in the southern half than in the northern half where it decreases very sharply and is scarcely found in the northern parts. HIDA's statement (1957) on the distribution of this species in the area, mentioned in the preceding section, shows clearly this trend; there, *P. draco* is abundant in the subtropic zone south to ca. 33°N, but decreases sharply in the transition zone.

e) Distribution of other prominent species.

i) *S. bipunctata*, HIDA (1957) includes this species as a very important form in the subtropic and transition zones, considering it comparable with *S. serratodentata*. Actually it occurred in considerable numbers at considerable frequencies in the Transpac Expedition collections as shown in Appendix Table 1, but it was much scarcer than *S. serratodentata pacifica*. It is not improbable that this species occurs abundantly in rather deep water and consequently is met with less frequently in the present material of the Transpac Expedition, which consists only of samples gathered from 50 m to the surface. BIERI (1959) say that the distribution of *S. californica* (=*S. bipunctata*) is antitropical, avoiding a narrow band in the equatorial region. The results of my examination on five of the samples of the Equapac Expedition show that *S. bipunctata* is not so rare in this region. It occurred also in considerale numbers in the material of the Syunkotu-Maru and also in the small sample from the Gilbert-Phoenix Islands, while it was quite absent in the materials of the Palao-New Guinea cruises. Probably, the population of *S. bipunctata* fluctuates rather violently in the equatorial region.

ii) *S. regularis*. According to the present data from the material examined, this species seems to occur more frequently and abundantly in the western half of the Central North Pacific than in the eastern half. It is found abundantly in waters adjacent to the *bedoti*-water in the western North Pacific, but this does not seem to suggest any special correlation between this species and *S. bedoti*, because the former is rather scarce in the *bedoti*-water of the Shellback area. In the central equatorial part of the Indian Ocean, the species occurs much more abundantly than does *S. hexaptera*.

iii) *S. minima*. The abundance of this species in or near the region of mixing between the *elegans*-water and the warm water has been repeatedly explained in previous sections. Its dominance is especially pronounced in the north-eastern part of the far oceanic water of the Central North Pacific, because *S. enflata* and even *S. serratodentata pacifica* are very scarce there. In the mixing area, it might easily be mistaken for young individuals of *S. elegans*, because the general external appearance is nearly the same between these two species. Very probably some slight errors are inevitable in counting these forms in the mixing area. However, the direction of fin rays, which is vertical in *S. minima* rather than oblique as in *S. elegans*, can be used as the apparent characteristic in separating immature *S. minima* and young *S. elegans*. *S. minima* is also fairly common in the waters off North and Central Chile (FAGETTI, 1958). Sometimes it occurs in considerable density in the tropical waters as seen in the material from the central equatorial part of the Indian Ocean (TOKIOKA 1956a) and in the material of the Eastropic Expedition (SUND, 1959c), although it is still very difficult, at present, to explain clearly the significance of such distributions.

8. DIFFERENTIATION FOUND IN THE CHAETOGNATH FAUNA OF THE NORTH PACIFIC AND THE RELATION BETWEEN COMMUNITIES AND WATER MASSES

The contents of the foregoing sections may be summarized as follows: —

1) Chaetognath fauna in the embayments.

i. *West side of the North Pacific*:– *Crassa*-water in the Inland Sea, Ise Bay, Tôkyô Bay and Mutu Bay of Honsyû, Japan, also in the coastal waters of Korea and in Kiauchau Bay of North China. *Delicata*-water in Maizuru Bay, Tanabe Bay, Katu-ura Bay and Ago Bay of Honsyû, Japan.

ii. *East side of the North Pacific*:– *Tenuis*-water in lagoons and small bays or inlets along lower California.

2) *Bedoti*-water.

i. *West side of the North Pacific*:– (1) In the mixing area between the *bedoti*-water and the *elegans*-water or between the former and the *crassa*-water in the Yellow Sea, respectively *S. elegans* and *S. bedoti* or *S. crassa* and *S. bedoti* represent the components of the fauna. In the former region *S. minima* and a small number of *S. enflata* may join the fauna at times.

(2) Then, there is a fairly wide area in the Yellow Sea and the East China Sea, where *S. bedoti* and *S. enflata* are the chief components.

(3) The greatest part of the *bedoti*-water is the mixing region between (2) and the warm oceanic water, where most of the warm oceanic species occur together with *S. bedoti*, although they are not so abundant as in the far oceanic water. Here, *S. enflata* predominates over other forms including *S. serratodentata pacifica*, *S. hexaptera* is very scarce. *P. draco* occurs in the southern part, but not in abundance. *S. regularis* is relatively common.

ii. *East side of the North Pacific*:– The *bedoti*-water here is characterized as in (3) mentioned in the preceding paragraph. The predominance of *S. enflata* over *S. serratodentata pacifica* is maintained here also. *S. hexaptera* occurs in considerable numbers as does also *P. draco*, since the area is situated in the tropics. However, *S. regularis* is rather scarce. Other than these species, there occur also in this area *S. serratodentata tasmanica*, *S. neodecipiens*, *S. ferox* f. *americana* and *S. friderici*. These are quite unknown from the western bedoti-water and according to present data *S. neodecipiens* and *S. ferox* f. *americana* are strictly confined to this area. Thus, the difference between the western and eastern *bedoti*-water is somewhat remarkable.

3) ***Friderici*-water along the Californian coast** (*cit.* p. 390).

4) ***Elegans*-water.**

It is unnecessary to discuss at length this very distinct subarctic water which together with *S. elegans* is inhabited by considerable numbers of *E. hamata* and a small number of *S. lyra*. Besides these, *Heterokrohnia mirabilis* is reported by TCHINDONOVA (1955) from the depths of the Kamchatka trench. In the mixing area between the *elegans*-water and adjacent far oceanic water, some deeper living species join *S. elegans* and *E. hamata* as important parts of the chaetognath fauna. These are *S. decipiens* and *S. planctonis* in the western Canadian coastal waters (LEA, 1955) and *S. hexaptera*, *S. bipunctata* and *S. serratodentata* in the area from 170°E to 145°W (HIDA, 1957) besides those mentioned already on pp. 389–390.

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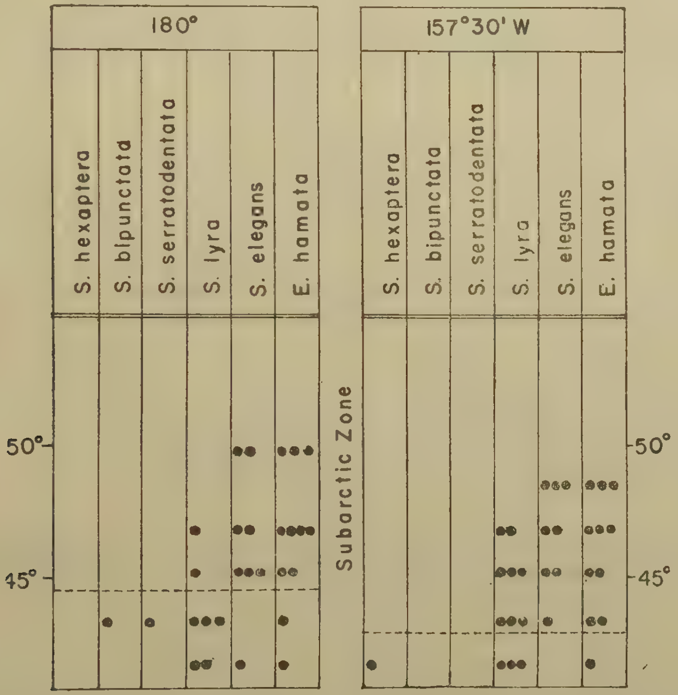

Fig. 32. Chaetognath fauna in the mixing area between the *elegans*-water and the North Pacific Central Water. (A part of Fig. 5 in HIDA's paper, 1957.)

5) ***Enflata* dominant Equatorial water.**

Here *S. enflata* predominates over *S. serratodentata pacifica*. BIERI (1959, p. 25) states that "the absence of *S. pulchra*, *S. neglecta*, *S. bedoti* and *S. pseudoserratodentata*, with *S. robusta*, *S. regularis*, and *Krohnitta pacifica* present, would place the sample in the oceanic region of the Equatorial Water Mass"; most probably the scarcity of *S. bipunctata* should be added to this in his opinion. In treating my data, I could discern clearly only a trend towards the S/E lower than 1.00 in this region; the samples I dealt with are rather few and too small to review BIERI's statement.

6) *Pacifica*-dominant oceanic water.

In this vast area of far oceanic water, *S. serratodentata pacifica* predominates numerically over *S. enflata*. This area can be divided into a northern transition zone characterized by prominent increase in *S. minima* and *S. lyra* and a southern subtropical to tropical zone characterized by the abundance of *P. draco* as is shown by HIDA (1957). The northern part is much narrower than the southern part. At the same time, this area is divisible into western and eastern halves, although the distinction is not very clear in the distribution of chaetognaths. The frequent occurrence of numerous *S. regularis* and relatively large population of *S. enflata* contrasted with more scarce occurrence of *S. hexaptera* are characteristics of the fauna in the western half and the extreme scarceness of *S. enflata* and *S. regularis* and the comparatively abundant occurrence of *S. hexaptera* are the features characterizing the fauna in the eastern half. These are all deductions from only the available material that I have examined and hence it is not certain whether or not all these trends are absolutely of universal or constant features. BIERI (1959) says "the absence of *S. robusta* and *S. regularis*, with *S. pseudoserratodentata* present, would show that the sample came from the Eastern North Pacific Central Water". At least, the scantiness of *S. regularis* in the eastern half is common to both BIERI's and my statements.

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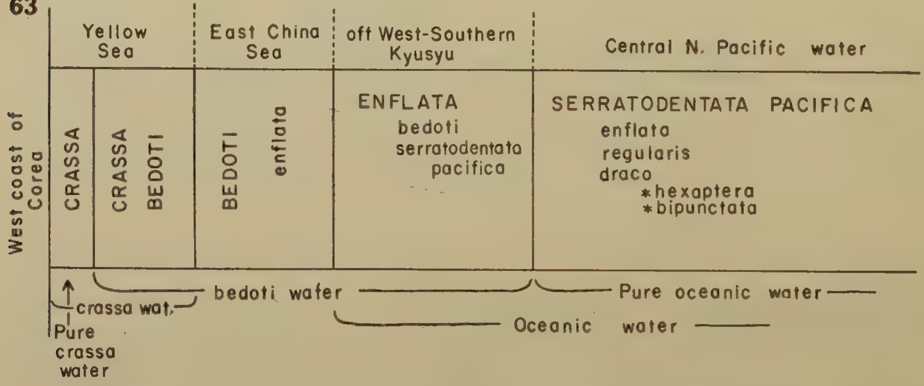

Fig. 33. Differentiation found in the chaetognath fauna along the line through the Yellow Sea, East China Sea, waters off West-South Kyûsyû and extending to the North Pacific Central Water.

It is evident that (5), *enflata*-dominant Equatorial Water, corresponds to Pacific Equatorial Water and that (6), *pacifica*-dominant oceanic water, corresponds to North Pacific Central Water. The predominance of *S. serratodentata* over *S. enflata* seems to be a characteristic of far oceanic water, since in the South Atlantic *S. serratodentata* was about 1.7 times as numerous as *S. enflata* as a whole, when the individuals of each species in a cylinder of water, 1000 m deep and 50 m in diameter, were compared (THIEL, 1938). As to the approximate situation of the boundary between the western and eastern halves of the chaetognath fauna in the North Pacific Central Water, I cannot add anything to the comment by BIERI (1959), since the material I dealt with is much smaller than his. HIDA (1957) made a comparison of chaetognath faunas in the subarctic, transition, and subtropic zones along 180° and 157°30′ W as found on

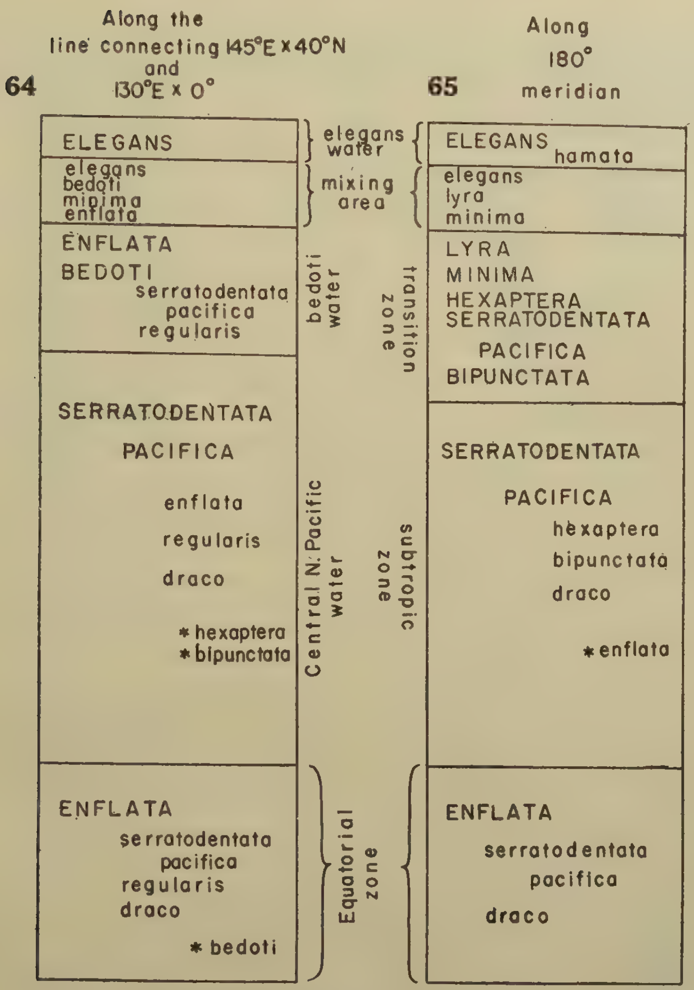

Fig. 34. Differentiation found in the chaetognath fauna along the line connecting 145°E×40°N and 130°E×0° (64) and along 180° meridian (65).

Hugh M. Smith Cruise 30. The slight narrowing of the transition zone along 157°30′W and the relative abundance of *S. minima* in the transitionz one along 180° is shown in his Fig. 5, but these do not seem to indicate any distinct boundaries between the east and western Central Wasters. Consequently, it is best, at present, to refrain from any attempts to correlate the Western and Eastern North Pacific Central Waters with the chaetognath fauna. The abun-

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Sag. serratodentata	305
Sag. enflata	179
Pterosag. draco	66
Sag. hexaptera	59.3

Table 74. Proportion of four important species in the South Atlantic. (THIEL, 1938).

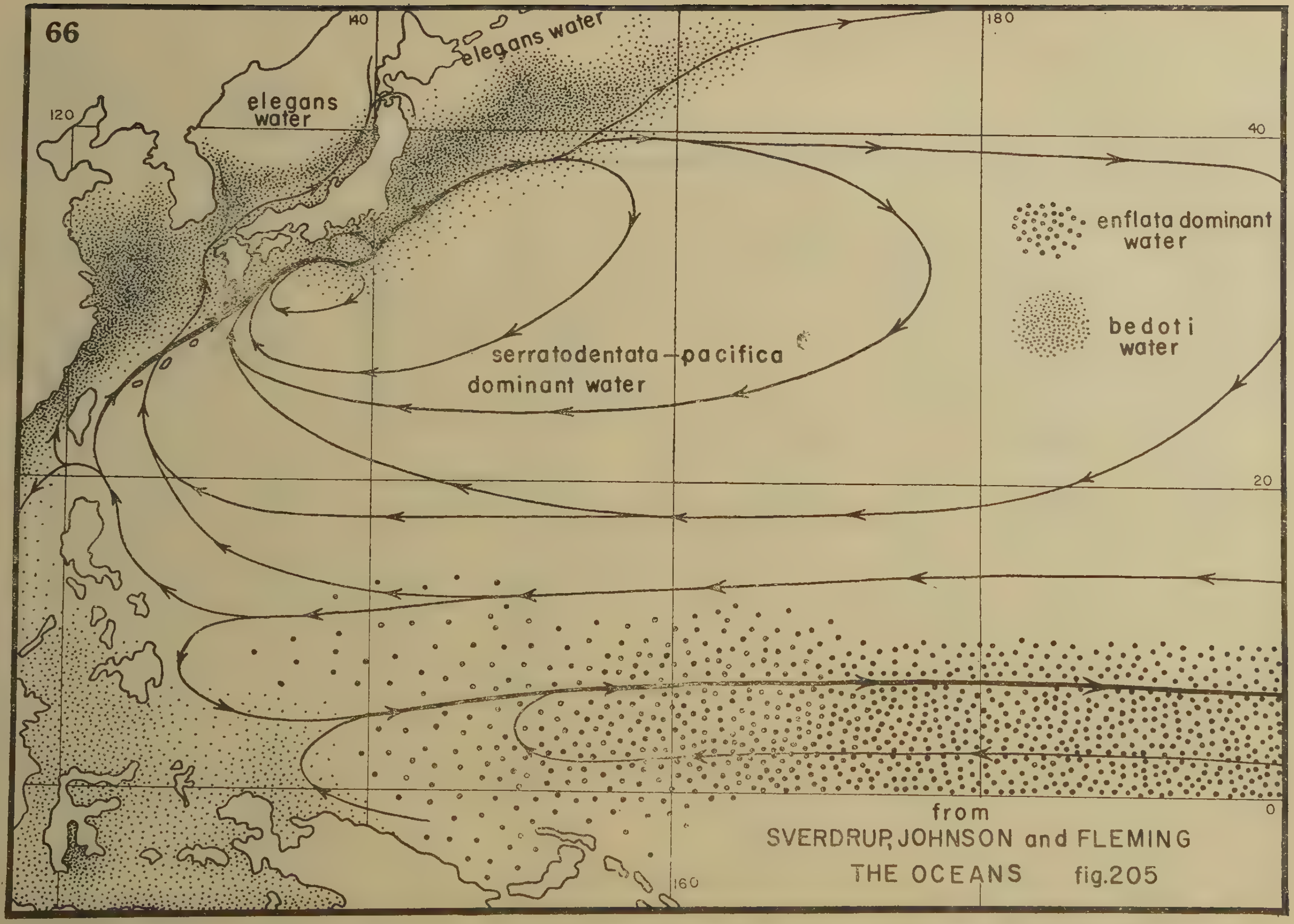

Fig. 35. Distribution of the *bedoti*-water and the *enflata*-dominant equatorial water plotted on the current chart from "The Ocean".

dance of *S. enflata* in the *bedoti*-water and the Equatorial water is significant in that both the *bedoti*-water and the Equatorial water hold denser population of not only chaetognaths but also of many other plankton organisms than does the North Pacific Central Water. *S. regularis* is abundant in the western half of both the North Pacific Central water and Equatorial water. It is very strange therefore that the species decreases greatly towards the east in spite of the existence of the eastward flowing Counter Equatorial Current. The degree of the lateral mixing along this current, which might induce dispersion or intake of various species of chaetognaths, must be studied more in detail in the future.

In the Indo-Pacific, *S. friderici* occurs only in the coastal waters along the western coast of the New World and the known occurrence of *S. tenuis* seems to confine it to the same region. These two species are reasonably considered as relicts of the Caribbean chaetognaths showing an ancient connexion between the Pacific and the Caribbean Sea, at which time they might have been carried into the Pacific by the westward Equatorial Current. But probably species characteristic to the Pacific, such as *S. bedoti* and *S. regularis*, could not penetrate into the Caribbean Sea against this current. At first, it appeared that *S. ferox* f. *americana* might be closely related with *S. hispida* or *S. helenae* in the Caribbean Sea, but this is not likely. The existence of more anterior teeth than posterior teeth in many individuals is merely a superficial coincidence between this and *S. helenae*; the existence of the distinct intestinal diverticula in *S. ferox* f. *americana* seems to be enough to separate it distinctly from *S. helenae* which lacks completely the intestinal diverticula. The distinction between this and *S. hispida* seems to be clear, though it is somewhat delicate as mentioned in the taxonomic part. Most probably this form differentiated from an ancestral *ferox*-group in the eastern *bedoti*-water as *S. neodecipiens* apparently did. *S. hispida* and *S. helenae* known commonly from the Caribbean Sea might have differentiated there after the connexion between that sea and the Pacific was closed and hence they do not occur in the Shellback area to-day. It is difficult to consider the western and eastern *bedoti*-waters in the Pacific as having developed independently of each other; long ago these two *bedoti*-waters might have been continous with each other. The differentiation of *S. neodecipiens* and *S. ferox* f. *americana* in the eastern *bedoti*-water seems to have started after the continuity between the eastern and western *bedoti*-waters was cut off. The chaetognath fauna in the eastern *bedoti*-water is evidently nourished partly by the northward Humboldt Current, since there are found a considerable number of *S. serratodentata tasmanica* and a small number of a special form of *S. enflata* (f. *gardineri*) having longer ovaries. Both of these are known from the waters off North and Central Chile.

Summary and Conclusions

1. A part of the plankton material, 326 samples in all, collected by and stored at the Scripps Institution of Oceanography were examined and the data obtained

concerning chaetognaths are given in 7 appended tables. Data from samples of the Palao-New Guinea cruises (1940) made by a Japanese survey ship are also given in an appended table.

2. Thirty forms of chaetognaths were discriminated throughout the whole material, one of these is a new species and another is a new form. A comparison was made between Pacific specimens of *S. tenuis* and *S. friderici*. Some notes are also given on the morphology and the range of variations in certain other species.

3. The chaetognath faunas of several embayments, the blue-green water along the Californian coast and of the north Subarctic waters are covered briefly.

4. An extensive area characterized by the occurrence of *S. bedoti* is discerned as a water-mass, here called "*bedoti*-water", which is distinct from the far oceanic water of the North Pacific.

5. The ranges of temperature and salinity of the water containing *S. bedoti* are very wide, leading to the assumption that it is a eurythermal and relatively euryhaline form. The small amount of the interchange of water, under favourable conditions for the species, between the *bedoti*-water and the adjoining water masses is considered the most important factor confining the species to the *bedoti*-water. Very probably the number of *S. bedoti* that are diffused into the neighbouring water mass from the "*bedoti*-water" by interchanging of the water might be less than the minimum required by this species for successful reproduction.

6. The distributions of ratios between *S. enflata* and each of *serratodentata pacifica*, *hexaptera* and *P. draco* (S/E, H/E and P/E) were examined. And the relation between these distributions and water masses of the North Pacific was studied. The Equatorial Water Mass is characterized by lower S/E and the North Pacific Central Water Mass is remarkable in maintaining a higher S/E.

7. The distinction between "*bedoti*-water" and far oceanic water of the North Pacific Central Water Mass and that between the latter and the Equatorial Water Mass were made clear by the studies mentioned above in 6. But the boundary between the Western North Pacific Central and the Eastern North Pacific Central Water Masses was not found distinctly by these studies, although the density of some species seems to trend towards one of these two water masses.

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(* referred through S. RAO's paper)

APPENDIX

Station data 1. For the small-net samples of the Transpac Expedition 1953.

Station	Number	Date	Time	Haul Distance in m	Line Angle
TP	1	VII 24	14.50	50	
TP	3	25		50	
TP	4	26		50	40°
TP	6	27	13.35–14.00	50	50°
TP	7	28	1.30	50	0°
TP	8	29	7.00	50	20°
TP	9	30	5.30	50	40°
TP	10	31	4.00	50	30°
TP	11	31	18.00	50	20°
TP	12	VIII 2		50	30°
TP	13	2		50	
TP	14	3		50	60°
TP	15	3		50	
TP	16	4	15.00		
TP	17	5		50	
TP	18	5	23.30	50	60°
TP	52	IX 8	4.00	50	30°
TP	56	11	6.15	50	30°
TP	57A	11	17.00	50	
TP	58A	12	9.00	50	45°
TP	59A	12	18.30	50	45°
TP	67	18	4.00		40°
TP	68	18	14.30	50	
TP	69	19	4.00		60°
TP	70	19	6.45	50	
TP	71	20	11.30	50	
TP	72	21	3.45	50	
TP	74	22	3.00	50	
TP	76	28	21.20	50	
TP	78	30	5.00	50	
TP	79	30	16.30	50	
TP	80	X 1	4.00	50	
TP	80	3000 m wire out. suspended below ca. 1000 fathoms, mid water trawl.			
TP	81	1			
TP	82	2	13.00	50	
TP	83	3	8.00	50	
TP	84	3	16.30	50	
TP	85	4	19.00	50	
TP	89	15	19.30	50	
TP	92A	18	12.45	50	
TP	93	24	3.45		25°
TP	94	24	10.15	50	20°
TP	95	24	10.57–11.21	1	
TP	96	25	8.00	50	
TP	97	25	16.05	50	30°
TP	98	26	9.00	50	45°

TP 99	X 26	22.15	50	
TP 99	27	10.06–12.10	Surface	
TP 100	29	0.45	50	60°
TP 101	29	12.30	50	
TP 102	30	6.30	50	50°
TP 103	30	19.30	50	0°
TP 104	31	9.45	50	30°
TP 105	31	19.45	50	45°
TP 106	XI 1	14.45	50	45°
TP 107	2	1.20		40°
TP 108	2	12.30	50	45°
TP 109	3	1.00		15°
TP 111	3	22.15	50	30°
TP 112	4	10.30	50	0°
TP 113	5	3.30		35°
TP 114	5	19.30	50	45°
TP 114	5	19.47–20.48	Surface	
TP 115	6	6.15		75°
TP 116	7	5.45	50	30°
TP 117	7		50	
TP 118	8	10.30	50	60°
TP 119	8		50	
TP 120	9	9.30	50	
TP 121	10	0.15	50	15°
TP 122	10	13.30	50	30°
TP 123	11	0.30		15°
TP 124	11	14.00	50	45°
TP 125	12	4.00		45°
Midway, off NE Reef inner side	12	10.00	Surface	
TP 126	13	2.30	50	45°
TP 127	13	13.00	50	45°
TP 128	14	2.15	50	45°
TP 129	14	15.00	50	45°
TP 130	15	8.00	50	60°
TP 131	15	23.00		55°
TP 132	16	13.30	50	60°
TP 133	17	4.00	50	
TP 134	17	17.30	50	30°
TP 135	18	8.00	50	50°
TP 137	22	22.08–22.31	Surface	
TP 141	26	23.03–22.30	Surface	

Station data 2. For the plankton samples collected by a Japanese survey ship and presented to the Transpac Expedition.

Station Number	Position	Date	Haul Distance	Line Angle
J 1	40°50′N × 142°05′E	Sept. 28, 1953	50 m	60°
J 2	40°52′N × 142°57′E	28	50	16°
J 3	40°53′N × 143°53′E	28	50	16°
J 4	40°49.5′N × 145°13′E	28	50	36°
J 5	40°07′N × 145°09′E	29	50	46°

Station Number	Position	Date	Haul Distance	Line Angle
J 6	39°32′N × 145°05′E	Sept. 29	50 m	43°
J 7	39°37′N × 143°58′E	29	50	7°
J 8	39°31′N × 142°53′E	29	50	3°
J 9	39°28′N × 142°20′E	30	50	36°
J 10	38°52′N × 142°12′E	30	50	0°
J 11	38°10′N × 141°47′E	30	50	8°
J 12	38°12′N × 142°36′E	Oct. 3	50	20°
J 13	38°14.5′N × 144°03.5′E	4	50	12°
J 14	38°16′N × 145°00′E	4	50	14°
J 15	37°30′N × 145°05′E	4	50	10°
J 16	36°51′N × 145°06′E	4	50	14°
J 17	36°38′N × 143°37′E	4	50	3°
J 18	36°38′N × 142°39′E	5	55	34°
J 19	36°20′N × 141°12′E	5	55	52°

Station data 3. For the sampling stations during the Palao–New Guinea Cruises (March–May 1940).

Station Number	Position	Date
2	6°19′N × 134°27.7′E	Mar. 17, 1940
3	5°40′N × 134°26.4′E	18
4	5°01′N × 134°25′E	18
5	4°30′N × 134°31′E	18
6	3°58′N × 134°38′E	18
7	3°27′N × 134°37′E	19
8	2°58′N × 134°39′E	19
9	2°29′N × 134°35′E	19
10	2°00′N × 134°30′E	19
11	1°29′N × 134°21′E	20
12	0°58′N × 134°10′E	20
13	0°30′N × 134°16′E	20
15	0.33′S × 134°27′E	21
52	6°57.4′N × 134°27.5′E	May 20, 1940
53	6°30′N × 134°30′E	20
54	6°56.8′N × 134°33.1′E	21
55	5°23.8′N × 134°36.1′E	21
56	4°50.5′N × 134°29.1′E	21
57	4°30′N × 134°32.5′E	21
58	4°03′N × 134°33.8′E	21
59	3°35.5′N × 134°35.7′E	22
60	3°07.8′N × 134°37.4′E	22
61	2°30′N × 134°32.1′E	22
62	2°00.5′N × 134°30.2′E	22
63	1°31.1′ × 134°28.4′E	23
64	1°02′N × 134°26.5′E	23
65	0°30.4′N × 134°24.1′E	23
66	0°02.5′N × 134°22′E	23
67	0°33′S × 134°21′E	24

1

(No. 1)

Stations	TP 1	TP 3	TP 4	TP 6	TP 7	TP 8	TP 9	TP 10	TP 11
Sag. hexaptera									
Sag. lyra	1								
Sag. enflata									
Sag. bipunctata				1					
Sag. ferox									
Sag. robusta									
Sag. bedoti									
Sag. friderici	12								
Sag. pacifica	6	1	3	7	1	8			
Sag. tasmanica	1								
Sag. pseudoserratodentata							4		
Sag. neglecta									
Sag. regularis									
Sag. crassa f. *naikaiensis*									
Sag. minima	12	8				1	6	4	6
Sag. deipiens									
Pterosag. draco									
Ktta. subtilis									
Ktta. pacifica									
Damaged specimens or juv.	45	46	* 1	* 5		* 2	* 7	1	
total number	77	55	4	13	1	11	17	5	6
number of species	5	2	1	2	1	2	2	1	1

* juv.

(No. 2)

Stations	TP 79	TP 80	TP 80	TP 81	TP 82	TP 83	TP 84	TP 85	TP 89
Sag. hexaptera			1		1				
Sag. lyra									
Sag. enflata	8	1	4	6	8	10		1	8
Sag. bipunctata				1	1		3		
Sag. ferox							1		
Sag. robusta	1			1	1	4			1
Sag. bedoti									
Sag. friderici									
Sag. pacifica	14	10	17	19	14	14	5	5	4
Sag. tasmanica									
Sag. pseudoserratodentata									
Sag. neglecta	2								
Sag. regularis	8	2		5	8	12	2	1	1
Sag. crassa f. *naikaiensis*									1
Sag. minima	1				1				1
Sag. decipiens									
Pterosag. draco	2		2		1				2
Ktta. subtilis			3						
Ktta. pacifica	2	2		3	2	1			1
Damaged specimens or juv.	16	3	11	7	13	10	7	6	* 27
total number	54	18	38	42	50	51	18	13	46
number of species	8	4	5	6	9	5	4	3	8

Appendix Table 1. Occurrence of chaetognaths in sam

TP 12	TP 13	TP 14	TP 15	TP 52	TP 59	TP 69	TP 70	TP 74	TP 76	TP 78
	1									
							2	18	23	9
					6	12	3	6	60	58
				1	1				3	
									1	2
							2	3	4	5
						3		1	2	
8	61	166	3		3	7	2	44	21	35
									1	
3	* 13	* 15	1	2	12	* 13	* 7	* 95	* 92	* 72
11	75	181	4	3	22	35	16	167	207	181
1	2	1	1	1	3	3	4	5	8	5

TP 92	TP 93	TP 94	TP 95	TP 96	TP 97	TP 98	TP 99	TP 99	Entrance to Yokosuka	TP 100
										1
24	58	7	24		3	3	2	52		4
	1		3	1	1			9		
			7		1	1		28		
	1		2					2		
	4	4	27	3	1	7	3	41		8
1				1						
		1	15		3	4	1	7		4
									80	
	1									4
1	1		4			1		15		4
1			3	1	2	3	1	1		1
* 68	* 92	18	21	11	12	1	10	20		8
95	158	30	106	17	23	20	17	175	80	34
4	6	3	8	4	6	6	4	8	1	7

ples of the Transpac Expediton. (Nos. 1–2)

1

(No. 3)

Stations	TP 101	TP 102	TP 103	TP 104	TP 105	TP 106	TP 107	TP 108	TP 109
Sag. hexaptera									
Sag. lyra									
Sag. enflata	4	4		4	2	2		1	5
Sag. bipunctata	3	2	1	3					
Sag. ferox		1							
Sag. robusta						1		1	
Sag. bedoti									
Sag. friderici									
Sag. pacifica	9	4	1	7	5	7	1	10	11
Sag. tasmanica									
Sag. pseudoserratodentata									
Sag. neglecta									
Sag. regularis	1					2		1	3
Sag. crassa f. *naikaiensis*									
Sag. minima		1			2			1	6
Sag. decipiens									
Pterosag. draco	2	2				1		2	4
Ktta. subtilis					1				
Ktta. pacifica	2			2		2			4
Damaged specimens or juv.	6	5	2	4	4	6		* 37	* 48
total number	27	19	4	20	14	21	1	53	81
number of species	6	6	2	4	4	6	1	6	6

* juv.

(No. 4)

Stations	TP 122	TP 123	TP 124	TP 125	TP 126	TP 127	TP 128	TP 129	TP 130
Sag. hexaptera				1					
Sag. lyra									
Sag. enflata									
Sag. bipunctata	2	2							
Sag. ferox									
Sag. robusta									
Sag. bedoti									
Sag. friderici									
Sag. pacifica			6	2	4		2	2	5
Sag. tasmanica									
Sag. pseudoserratodentata									
Sag. neglecta									
Sag. regularis				1					
Sag. crassa f. *naikaiensis*									
Sag. minima									
Sag. decipiens									
Pterosag. draco		2	1		3		1		
Ktta. subtilis									
Ktta. pacifica									
Damaged specimens or juv.	1		6	5	1	2	2	2	2
total number	3	4	13	9	8	2	5	4	7
number of species	1	2	2	3	2	—	2	1	1

* TP 131 large net hauled from 450 m. * St. 89 Stranger: North Pacific

Appendix Table 1 (continued). Occurrence of chaetognaths

TP 12	TP 13	TP 14	TP 15	TP 52	TP 59	TP 69	TP 70	TP 74	TP 76	TP 78
	1									
							2	18	23	9
					6	12	3	6	60	58
				1	1				3	
									1	2
							2	3	4	5
						3		1	2	
8	61	166	3		3	7	2	44	21	35
									1	
3	* 13	* 15	1	2	12	* 13	* 7	* 95	* 92	* 72
11	75	181	4	3	22	35	16	167	207	181
1	2	1	1	1	3	3	4	5	8	5

TP 92	TP 93	TP 94	TP 95	TP 96	TP 97	TP 98	TP 99	TP 99	Entrance to Yokosuka	TP 100
										1
24	58	7	24		3	3	2	52		4
	1		3	1	1			9		
			7		1	1		28		
	1		2					2		
	4	4	27	3	1	7	3	41		8
1				1						
		1	15		3	4	1	7		4
									80	
	1									4
1	1		4			1		15		4
1			3	1	2	3	1	1		1
* 68	* 92	18	21	11	12	1	10	20		8
95	158	30	106	17	23	20	17	175	80	34
4	6	3	8	4	6	6	4	8	1	7

ples of the Transpac Expediton. (Nos. 1–2)

1

(No. 3)

Stations	TP 101	TP 102	TP 103	TP 104	TP 105	TP 106	TP 107	TP 108	TP 109
Sag. hexaptera									
Sag. lyra									
Sag. enflata	4	4		4	2	2		1	5
Sag. bipunctata	3	2	1	3					
Sag. ferox		1							
Sag. robusta						1		1	
Sag. bedoti									
Sag. friderici									
Sag. pacifica	9	4	1	7	5	7	1	10	11
Sag. tasmanica									
Sag. pseudoserratodentata									
Sag. neglecta									
Sag. regularis	1					2		1	3
Sag. crassa f. *naikaiensis*									
Sag. minima		1			2			1	6
Sag. decipiens									
Pterosag. draco	2	2				1		2	4
Ktta. subtilis					1				
Ktta. pacifica	2			2		2			4
Damaged specimens or juv.	6	5	2	4	4	6		* 37	* 48
total number	27	19	4	20	14	21	1	53	81
number of species	6	6	2	4	4	6	1	6	6

* juv.

(No. 4)

Stations	TP 122	TP 123	TP 124	TP 125	TP 126	TP 127	TP 128	TP 129	TP 130
Sag. hexaptera				1					
Sag. lyra									
Sag. enflata									
Sag. bipunctata	2	2							
Sag. ferox									
Sag. robusta									
Sag. bedoti									
Sag. friderici									
Sag. pacifica			6	2	4		2	2	5
Sag. tasmanica									
Sag. pseudoserratodentata									
Sag. neglecta									
Sag. regularis				1					
Sag. crassa f. *naikaiensis*									
Sag. minima									
Sag. decipiens									
Pterosag. draco		2	1		3		1		
Ktta. subtilis									
Ktta. pacifica									
Damaged specimens or juv.	1		6	5	1	2	2	2	2
total number	3	4	13	9	8	2	5	4	7
number of species	1	2	2	3	2	—	2	1	1

* TP 131 large net hauled from 450 m. * St. 89 Stranger: North Pacific

Appendix Table 1 (continued). Occurrence of chaetognaths

TP 111	TP 112	TP 113	TP 114	TP 115	TP 116	TP 117	TP 118	TP 119	TP 120	TP 121
								1		
1	1		1				1		1	
								1		
2			8	6	2	1	11	6	1	1
3	14	5			3		1			
1						1	2			2
1										
5	8	3			1	2	7	5	3	2
13	23	8	9	6	6	4	22	13	5	5
5	2	1	2	1	2	2	4	3	2	2

TP 131	*TP 131	TP 132	TP 133	TP 134	TP 135	TP 137	TP 141	*St. 89	F. O.	Mean percentage
	232				2		4		10	8
	30								4	1
	117			1	1	1			46	14
	24								23	13
									3	6
	6								15	5
									12	17
									1	16
1	401	1			4	15	21	4	74	37
									1	1
	22					1	1		5	9
									6	2
									31	9
									6	* 3
	16								40	30
	4								1	*
2	329	2	1	3	3	1	8		40	15
	97								4	7
	30		1	1	1				31	7
2	76	8	1	2	9	1	1		90	38
5	1384	11	3	7	20	19	35	4		
2	12	2	2	3	5	4	4	1		

* 3 Yokosuka excluded.

5509–2nd, 23.00.

n samples of the Transpac Expedition. (Nos. 3–4)

Stations	TP 19	TP 20	TP 21	TP 22	TP 23	TP 24	TP 25	TP 26	T
Situation	48-14.2 N 153-20.1 W	49-29.5 N 154-56.5 W	50-25.0 N 156-37.0 W	51-21.3 N 158-20.0 W	52-10.4 N 160-0.80 W	53-15.0 N 161-55.0 W	53-32.5 N 163-20.8 W	54-00.0 N 168-19.8 W	54 170
Date	Aug. 6	Aug. 7	Aug. 8	Aug. 8		Aug. 9	Aug. 10	Aug. 12	Au
Time		9.00		12.00				11.30	1
Haul distance (m.)	0-50	0-50		0-50	*	0-50		0-50	
Rope angle				45°		50°			
Sag. elegans	2	6	5	10	23	9	2	6	
Eukr. hamata		1	1						
Damaged specimens or juv.									
total number	2	7	6	10	23	9	2	6	

* ♯20 Net used.

Stations	TP 40	TP 41	TP 42	TP 43	TP 44	TP 45	TP 46	TP 47	T
Situation	53-57.0 N 171-10.8 E	53-32.1 N 168-50.8 E	53-32.4 N 166-10.8 E	53-35.5 N 163-42.0 E	53-40.8 N 161-55.5 E	52-23.0 N 163-15.2 E	51-13.0 N 164-34.3 E	49-50.1 N 165 49.2 E	48 166
Date	Aug. 30		Sep. 1	Sep. 1	Sep. 2	Sep. 3	Sep. 3	Sep. 4	Se
Time	12.45		6.00	23.00	5.00	8.15	19.00	17.30	1
Haul distance (m.)	0-50		0-50		0-50		0-50	0-50	0
Rope angle	45°	15°		40°		40°			
Sag. elegans	6	2	6	1	7	1	1	1	
Eukr. hamata									
Damaged specimens or juv.						5		1	
total number	6	2	6	1	7	6	1	2	

Appendix Table 2. Chaetognaths occurred in the

(No. 1)

? 27	TP 28	TP 29	TP 30	TP 31	TP 32	TP 33	TP 34	TP 35	TP 36	TP 37	TP 38	TP 39
-00.0 N -03.0 W	53–59.5 N 171–40.0 W	54–00.0 N 173–15.5 W	53–57.7 N 175 04.5 W	53–15.6 N 175–37.6 W	52–29.3 N 176–09.0 W	52–19.9 N 176–57.5 W	53 -10.3 N 177–59.0 W	54 -05.5 N 178–56.2 W	54–00.9 N 178 -58.7 E	53 59.0 N 176–55.0 E	53–59.1 N 174–49.0 E	54–03.1 N 172–28.8 E
g. 13				Aug. 15	Aug. 15	Aug. 24	Aug. 25	Aug. 25	Aug. 26	Aug. 27	Aug. 28	Aug. 29
0.30		6.45				20.00	10.00	18.30	10.30		13.30	3.15
	0–50	0–50		0–50	0–50	0–50	0–50	0–50	0 50		0–50	0–50
40°				20°	0°	45°	60°	60°	60°	70°	60°	60°
11	4	8	2	9	2	3	22	21	82	26	17	15
11	4	8	2	9	2	3	22	21	82	26	17	15

(No. 2)

? 48	TP 49	TP 50	TP 51	TP 53	TP 55	TP 61	TP 63	TP 64	TP 65	TP 66	TP 73	
-46.3 N -48.1 E	47–35.7 N 167–44.8 E	46–16.5 N 168–52.2 E	45 05.5 N 170- 08.5 E	42–07.9 N 169–28.1 E	41–19.0 N 168–20.2 E	45–15.1 N 158 -20.0 E	46–23.5 N 155–28.6 E	46–54.5 N 153–55.2 E	45–29.9 N 154–19.7 E	44–09.0 N 152–56.8 E	40–53.4 N 143–51.5 E	
p. 5	Sep. 6	Sep. 6	Sep. 7	Sep. 8	Sep. 10	Sep. 14	Sep. 15	Sep. 15	Sep. 16	Sep. 17	Sep. 21	
1.00		14.45	11.15	15.25	6.45	9.00	5.45	20.45	10.30	9.00	4.30	
50		0–50	0 -50	0–50	0–50	0–50	0–50	0–50	0–50	0–50	0 50	
	40°		30°	30°		45°	60°	45°	10°			F.O.
2	10	3		5		2	6	4	3	* 4	2	95
												5
		1	1	1	1						1	17
2	10	4	1	6	1	2	6	4	3	4	3	

* One of the four is *Sag. minima* ?

legans-water during the Transpac Expedition. (Nos. 1–2)

3

Positions	East of 160°W			West of 170°E		
	TP 16	TP 17	TP 18	TP 56	TP 67	TP 68
Sag. lyra	1	1	1			
Sag. enflata				1		
Sag. elegans	1	1	3	3	9	9
Sag. bedoti						
Sag. crassa f. *naikaiensis*						
Sag. minima	5				3	2
Damaged specimens or juv.	3	2	4		1	
total number	10	4	8	4	13	11
number of species	3	2	2	2	2	2

Appendix Table 3. Chaetognaths occurred in samples from the northern mi

4

Positions	J 1	J 2	J 5	J 6	J 7	J 8	J 9	J 11	J 12
Sag. enflata	22		1	3	6			1	2
Sag. bipunctata			1						
Sag. ferox									
Sag. bedoti	16	1	2	1	18	1	4	9	1
Sag. pacifica	1	1	1	1	1				
Sag. neglecta					1				2
Sag. regularis	1		4	1	1				2
Sag. crassa f. *naikaiensis*		1						1	
Sag. minima	108	5	3	15	2		6	3	9
Damaged specimens or juv.	124		9	16	84	2	6	26	28
total number	272	8	21	37	113	3	16	40	44
number of species	5	4	6	5	6	1	2	4	5

Appendix Table 4. Chaetognaths occurred in samples from

West of 150°E					
TP 71	J 3	J 4	J 10	F. O.	Mean percentage
				30	16
			1	20	19
6	5	1	1	100	47
3	1		2	30	18
2			1	20	10
3		1	2	60	30
14			1	60	33
28	6	2	8		
4	2	2	5		

ing area of the *elegans*-water and the warm water.

J 13	J 14	J 15	J 16	J 17	J 18	J 19	F. O.	Mean percentage
2	2	2			3	12	69	12
	1						13	5
					1	2	13	9
						17	63	16
1	2	3		2		1	63	11
							13	3
3	2	3	2		1	1	69	15
							13	8
3	1					9	69	23
13	15		1	3	2	30	88	52
22	23	8	3	5	7	72		
4	5	3	1	1	3	6		

ne North-Eastern waters of Japan.

5

(N

Stations	MP 1			MP 2		MP 3							
number of jar	J 1	J 2	J 3	J 4	J 6	J 7	J 8	J 9	J 10	J 11	J 12	J 12	J 1
Sag. hexaptera			3		2					1		2	5
Sag. enflata	1	3		4	4	1		6	2	47	17	36	61
Sag. bipunctata													1
Sag. ferox													
Sag. robusta												1	
Sag. pulchra													
Sag. pacifica	* 106	* 134	71	5	5			27	45	2	3	34	51
Sag. pseudoserratodentata	23	29	6									1	1
Sag. neglecta													
Sag. regularis								1					
Sag. minima	60	95	7	3									
Sag. planctonis													
Sag. macrocephala													
Pterosag. draco			3					3		23	9	8	12
Ktta. subtilis	2	1		2	4					1	1		12
Ktta. pacifica													
Eukr. hamata													
Damaged specimens or juv.	16	16	31	3	17			7	7	1	3	20	34
total number	208	278	121	17	32	1	0	44	54	75	33	102	177
number of species	5	5	5	4	4	1	0	4	2	5	4	6	7

* *pseudoserratodentata* juv. included?

(No

Stations	MP 12					MP 14	MP 15	MP 16		MP 17		
number of jar	J 40	J 41	J 42	J 43	J 44	J 46	J 47	J 48	J 50	J 51	J 52	J 55
Sag. hexaptera	1	4			15	45	1	244	23			5
Sag. enflata	22	12		3	49	384	19	30				1
Sag. bipunctata	2							3				
Sag. ferox	2	1										
Sag. robusta	16	2			15							
Sag. pulchra						1						
Sag. pacifica	10	2		3	140	8	7	48	2	5		13
Sag. pseudoserratodentata					1			1				
Sag. neglecta				1								
Sag. regularis		1										
Sag. minima								1				
Sag. planctonis					1							
Sag. macrocephala							1					
Pterosag. draco	29	25	2	1	154	52		104	2	1		1
Ktta. subtilis					2	1			2			
Ktta. pacifica	1				1							
Eukr. hamata												
Damaged specimens or juv.	52	15		3	36	125	2	39	4	1		1
total number	135	62	2	11	414	616	30	470	33	7	0	21
number of species	8	7	1	4	9	6	4	7	4	2	0	4

Appendix Table 5. Occurrence of chaetognaths

1)

	MP 5			MP 7		MP 8				MP 10						
J 15	J 16	J 18	J 21	J 23	J 25	J 26	J 28	J 30	J 30	J 32	J 33	J 34	J 35	J 37	J 38	J 39
		1	2	47	4	23			1	37	2	62	12		7	5
5		10	12	103	25	218		15	16	18	1	41	25	10	13	13
						1									1	
			* 1							3				23	7	17
11			1	5	2	74			5	65	1	30	101	54	30	31
2															1	
													1			
						1									1	
4		1		13	1	12				283	14	283	170	31	24	55
						1				4		2			1	
												1				1
					1											1
3		25	22	16	11	60	3	3	8	10	6	* 47	10	12	46	6
25	0	37	38	184	44	390	3	18	30	420	24	466	319	130	131	129
4	0	3	4	4	5	7	—	1	3	6	4	6	5	4	9	7

* or *ferox* f. *americana* juv.?

* juv.

2)

MP 18			MP 20						MP 35	MP 36		MP 41		F. O.	Mean percentage
J 56	J 57	J 57	J 62	J 64	J 64	J 65	J 66	J 67	J 69	J 70	J 71	J 73	J 74		
3	3	19	6	1	16	28	7	24	1	24	25	6	4	68	11
2		4	2		14	29	7	21	4	20	26	20	12	81	24
					1		1		2		1	1	1	19	1
														4	2
					2			2		2				21	3
														2	*
10	33	43	17	4	48	61	42	93	16	41	61	30	26	84	30
		7	4		1	4		3		1			1	28	4
											2			4	6
					1		2			2		1	2	14	1
			1											14	11
														2	*
														2	3
2		11	4		17	35	22	19	4	12	15	18	6	70	21
	1	2					2	1		2	2			35	3
								2	2					11	1
														4	2
5	35	34	12	3	64	11	52	37	15	34	49	38	25	89	23
22	72	120	46	8	164	168	135	202	44	138	181	114	77		
4	3	6	6	2	8	5	7	8	7	8	7	6	7		

n samples of the Midpac Expedition. (Nos. 1–2)

Stations	S B 1	S B 5	S B 10	S B 15	S B 20	S B 25	S B 30	S B 35	S B 40	S B 44	S B 50
Sag. hexaptera	4	18	13	11	63	25	16	65	209	140	30
Sag. lyra	41	2			14	5	14	14	171	29	4
Sag. enflata	33	12	105	460	694	616	182	285	160	391	54
Sag. bipunctata	13		28		14	4					
Sag. ferox f. *americana*				1	4						
Sag. robusta				1	7	3				1	
Sag. bedoti					1			5		6	
Sag. pulchra								1			1
Sag. friderici	101	23									1
Sag. pacifica	50	273	29	76	64	38	111	150	377	222	324
Sag. tasmanica	247	17	15	18	27	28	88	264	5	108	131
Sag. pseudoserratodentata	11	49	3								3
Sag. neglecta											1
Sag. regularis				1			18	9	14	32	8
Sag. minima	137	9	2	5	15	2	17	5	8	31	15
Sag. decipiens	39					2	4	12	10	1	25
Sag. neodecipiens	20										13
Sag. planctonis	2						2		1		
Pterosag. draco		5	17	28	213	290	27	120	16	203	22
Ktta. subtilis	8	44	22	3		23	51	53	68	51	40
Ktta. pacifica			1	5			10	5		5	4
Eukr. hamata						1	2	4	22	6	2
Damaged specimens or juv.	82	20	13	23	16	12	10	44	73	23	21
total number	788	472	248	632	1132	1049	552	1036	1134	1249	699
number of species	13	10	10	11	11	12	13	14	12	14	17

Appendix Table 6. Occurrence of chaetognaths in s

S B 55	S B 60	S B 64	S B 68	S B 71	S B 75	S B 80	S B 85	S B 90	S B 95	S B 100	S B 105	S B 109	S B 112
141	109	21	18	31	25	20	149	56	168	44	101	70	65
11						9	4	33	11	49	13	7	15
408	204	109	179	43	69	526	408	773	597	927	723	188	721
1	3	2		2	5								
3	70	65	69	58	69								
11	16	2		2	1			4	4	75	13		
20	38	4	137	1	12	32		1	1	15	7	101	
2	1		2			27	6		1	1	1		
							3	7	1	1	8	36	3
401	144	92	157	148	115	211	170	126	296	287	383	45	178
41		2	7	2	4	35	71	71	13	26	140	169	39
						1							
6	38	3	18	3	2	3		1				5	
22	5	2			2	52	45	38	26	149	29	1	1
7	3			2	1	39	35	10	10	5	11	23	27
7					2	4	17	15	3	6	9	1	1
											1		9
													2
209	172	10	4	13	13	81	182	93	404	326	178	12	18
51	2	3	1		2	42	40	41	10	112	84	48	31
11	3	15	17	11	1	24	1	1	20	7	4		
								7	4		3	3	
57	46	29	19	6	40	217	91	123	226	236	251	162	51
1409	854	359	628	322	363	1323	1222	1400	1795	2266	1959	871	1161
17	14	13	11	12	15	15	13	16	16	15	17	14	13

amples of the Shellback Expedition. (No. 1)

Stations	S B 115	S B 118	S B 122	S B 125	S B 130	S B 132	S B 137	S B 142	S B 145	S B 150	S B 155	S 1
Sag. hexaptera	60	18	85	29	12	15	3	16	39	40	75	
Sag. lyra	5	7	2	9				1	10	16	28	
Sag. enflata	267	52	398	42	155	31	42	226	567	374	527	3
Sag. bipunctata												
Sag. ferox f. *americana*												
Sag. robusta								2	3	8	8	
Sag. bedoti											30	
Sag. pulchra											42	
Sag. friderici		1	1									
Sag. pacifica	635	117	34	80	156	70	92	116	382	308	400	4
Sag. tasmanica	97	25	43	17	18	26	202	55	86	85	87	
Sag. pseudoserratodentata												
Sag. neglecta											1	
Sag. regularis	3	1							2	30	4	
Sag. minima	7	1	6	3	4	3	11	8	4	1	32	
Sag. decipiens			15		3				5	2	20	
Sag. neodecipiens			3		1				1	1		
Sag. planctonis												
Pterosag. draco	77	9	1	6	11	1	43	218	219	59	208	3
Ktta. subtilis	2	2	10	2	30		10	15	9	7	67	
Ktta. pacifica	1	1			2	5	60	186	85	9	63	
Eukr. hamata		1									16	
Damaged specimens or juv.	48	48	11	12	31	18	19	22	86	19	100	
total number	1202	283	609	200	423	169	482	865	1498	959	1708	14
number of species	10	12	11	8	10	7	8	10	13	13	16	

Appendix Table 6 (continued). Occurrence of chaetognaths

B 50	S B 166	S B 170	S B 175	S B 180	S B 181	S B 187	S B 195	S B 200	S B 210	S B 215	S B 217	F.O.	Mean percentage
59	55	168	71	59	40	52	46	25	4		2	98	6
11		2	26	62	5	2		1		1	4	73	2
50	416	895	333	366	315	811	83	1118	116	429	433	100	33
1			3					10				25	1
16	1		19	1		4		13	101			31	6
4			8	5	4		2	5				48	1
11	215	299	27	41	7	131	12	105		1	2	56	4
11	201	136	16	38	6	51		48				39	2
												25	2
03	106	186	235	324	234	318	31	238	156	78	171	100	22
53	1	8	121	173	83	278	55	8	72	113	86	98	8
								2		5	3	17	2
19	5	29	4		1	7	2	8	1			42	1
15			10	7	59	3	8	17	2		1	67	2
1	5	12	19	14	36	3	10	1	6	53	183	96	2
10			10	14	5	6	6	10	1		15	65	1
					1					1	3	23	1
		1										10	*
08	21	34	283	140	94	98	71	483	16	1		96	9
89	13	64	89	147	8	82	15	20		5	9	92	3
30	76	26	71	10	13	26	2	12	63	7	4	81	2
												25	*
38	18	79	38	610	11	55	73	24	24	46	23	100	6
39	1133	1939	1383	2011	922	1927	416	2148	562	740	939		
17	12	13	17	15	16	15	13	18	11	11	13		

* less than 0.5

in samples of the Shellback Expedition. (No. 2)

Stations	EQP S 28	EQP H 3	EQP H 7	EQP H 11	EQP H 17	F. O.	Mean percentage
Sag. hexaptera	109	29	41	62	57	100	13
Sag. enflata	688	56	180	431	348	100	40
Sag. bipunctata	12	6	1	1	32	100	2
Sag. ferox	1	2			6	60	1
Sag. robusta	5	3	5	9	9	100	1
Sag. pulchra				17	2	40	1
Sag. pacifica	203	60	66	231	35	100	17
Sag. pseudoserratodentata			3			20	1
Sag. neglecta	5					20	*
Sag. oceania	7					20	1
Sag. regularis	29	1	7	20	32	100	2
Sag. minima				2		20	*
Sag. decipiens	14	1	8	17	26	100	2
Pterosag. draco	73	21	81	204	315	100	17
Ktta. subtilis		1	5	1	2	80	1
Ktta. pacifica				12	15	40	2
Damaged specimens or juv.	99	9	113	63	29	100	9
total number	1245	189	510	1070	908		
number of species	11	10	10	12	12		

* less than 0.5

Appendix Table 7. Occurrence of chaetognaths in samples of the Equapac Expedition.

	North Equatorial Current					Counter Equatorial Current									
Stations	2	3	4	52	53	5	6	7	8	54	55	56	57	58	5
Sag. hexaptera										3					
Sag. enflata	3		7	3	28	14	6	47	28	20	12	21	12	7	
Sag. ferox				3	6					2			2		
Sag. bedoti						9	8	28	5	1	3	7	3		
Sag. pulchra												5			
Sag. pacifica	1	1			2	6	1	4	32			5	9	12	1
Sag. neglecta					2	3			1	1					
Sag. regularis	3	3	10		18	15	7	12	7	7	20	1	6		
Sag. bedfordii															
Pterosag. draco						5	1	5	7	1	4	11	2	1	
Ktta. subtilis								1							
Ktta. pacifica						7	2		6				1		
Damaged specimens or juv.					18		1								
total number	7	4	17	6	74	59	26	97	86	35	39	50	35	20	1
number of species	3	2	2	2	5	7	6	6	7	7	4	6	7	3	

Sts. 2–15 March, Sts. 52–67 May.

Appendix Table 8. Occurrence of chaetognaths in samples col

	South Equatorial Current														
60	9	10	11	12	13	15	61	62	63	64	65	66	67	F. O.	Mean percentage
1						1			2					14	5
3	37	8	25	20	17	16	17	30	49	47	50	61	12	97	35
					1				3				2	24	11
	22	5	7	3		2	1	12		10	17	18	24	69	13
												4		7	7
5	25	12	5	6	11	21	10	10	6	5	7	20	8	86	20
	2		4	1	3	14	1		30	10	6	8	15	52	8
	15	5	1	5	11		10	16	17	11	26	20	3	86	21
		1						3				1		10	2
6	8	5	9	8	4		10	9	3	8	14	11	6	79	11
														3	1
	1	1		2	1	8	1			2	1	6	6	48	5
						29		13	1	2		1		24	11
15	110	37	51	45	48	91	50	93	111	95	121	140	76		
4	7	7	6	7	7	6	7	6	7	7	7	9	8		

ected during the Palao—New Guinea cruises, 1940.

CONTRIBUTIONS TO JAPANESE ASCIDIAN FAUNA
XV. SPORADIC MEMORANDUM (6)
Styela clava var. *symmetrica* nov., a new pedunculate styelid from the Inland Sea.[1]

TAKASI TOKIOKA

Seto Marine Biological Laboratory, Sirahama

With one Text-figure

Since Dr. R. H. MILLAR asked me to send him some specimens of *Styela clava* HERDMAN to compare them with *Styela mammiculata* CARLISLE from the Plymouth Sound, I took several individuals out of the bottle labelled "*Styela clava* HERDMAN collected in August 1937 at Kada, Kii" and sent them to Dr. MILLAR. Later, he gave me a letter in which he stated that the specimens he received were not *S. clava* but *Styela longipedata* TOKIOKA, because they had each two gonads on each side, and asked me to send him some other specimens of real *S. clava*. I was very surprised at his information as I had never doubted but that these specimens were *S. clava*. None of the specimens conserved in the same bottle was dissected for identification, but the external appearance of these specimens is quite the same as that of the specimens of *S. clava* which I dissected for identification. Hurriedly I picked ten more individuals out of that bottle, dissected them and found that all of them were provided with two gonads on each side as stated by Dr. MILLAR in his letter. The existence of two gonads on each side is evidently a character common to all specimens collected at Kada and conserved in the same bottle. For comparison, I dissected a few specimens collected in Kasaoka Bay of the Inland Sea, one of which was related so closely in the external appearance to the specimens from Kada that I expected that this specimen might have two gonads on each side. All the dissected specimens were, however, provided with more than three gonads on each side; they were true *S. clava*.

Then I examined again the specimens from Kada in detail. This time I noticed the following tendencies in the external appearance: (1) the stalk is comparatively shorter than in *S. clava* and (2) protuberances on the body surface are always very prominent and especially those around the apertures are much larger than in *S. clava* (fig. 1). The stalk occupies 18–31% of the total body length and 26% on an average. In

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1) Contributions from the Seto Marine Biological Laboratory, No. 340.

Publ. Seto Mar. Biol. Lab., VII (3), 1959. (Article 26)

S. clava, the stalk is very variable in length. The specimens described by Traustedt (1885, Pl. III fig. 26, specimens from Kôbe and Hakodate) and Redikorzev (1916, Pl. V fig. 7) seem to be practically devoid of the peduncular portion, while Herdman's original specimens from Kôbe have considerably long stalk attaining 36–44% of the total body length (1882, Pl. XIX fig. 9) and Oka's specimens from Mutu Bay (1935) have the stalk nearly as long as the body proper. Specimens from Kasaoka Bay seem to be provided with specially long stalk; it occupies 54% of the total body length in a 162 mm long individual, but up to 64% in a 110 mm long specimen. Further, there are the following data:–

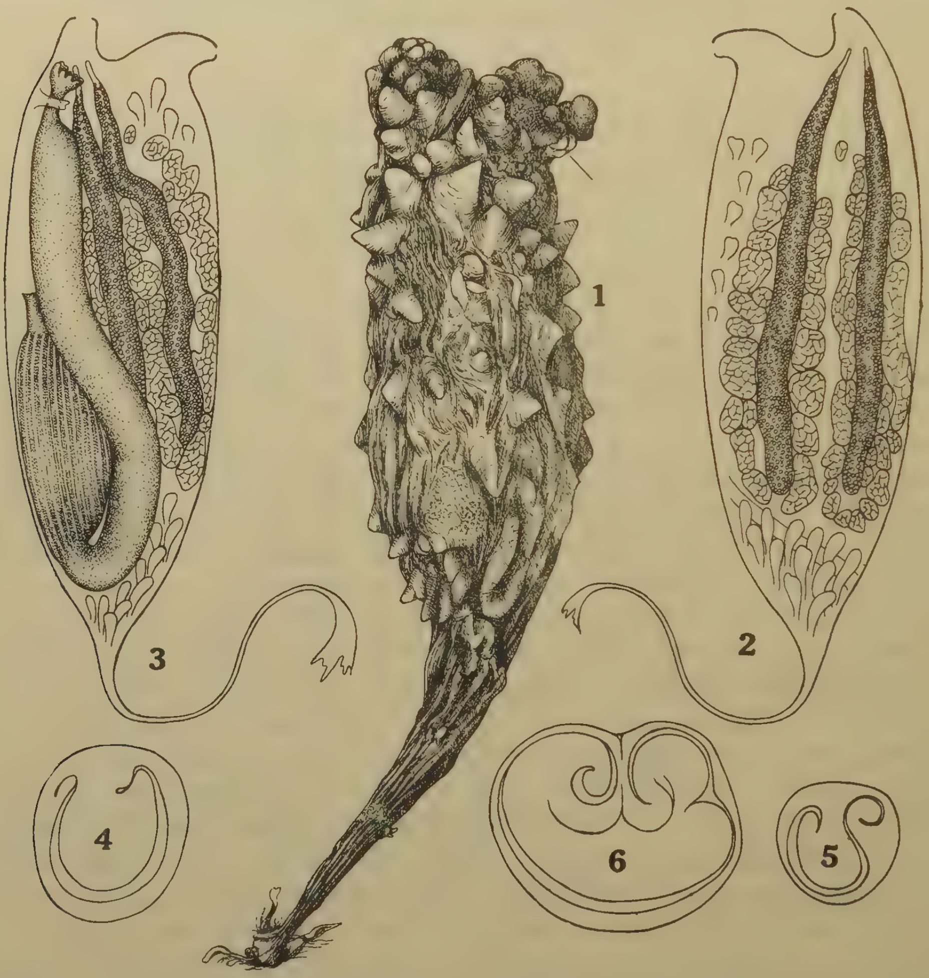

Fig. 1. *Styela clava* var. *symmetrica* nov. (1–4) 1···Entire animal from Kada, 2···Inside of the right half of mantle body, 3···Inside of the left half of mantle body, 4···Ciliated groove. *Styela clava* Herdman from Kasaoka Bay (5–6) Ciliated grooves.

TOKIOKA (1951a), Specimens from Akkesi, Hokkaidô, the stalk occupies about 50% of the total body length; (1953a), Specimens from Sagami Bay, 32% long stalk in a 103 mm long individual; (1954), Specimens from Ôsaka Bay, 45% long stalk in two 40 mm long individuals; (1959), Specimens from Wakasa Bay, 58% long stalk in a 60 mm long individual.

The body surface of *S. clava* is usually covered in the anterior half by irregularly shaped knobs (OKA 1935); they are not so prominent in TRAUSTEDT's (1885), REDIKORZEV's (1916) and TOKIOKA's (1951a, from Akkesi Bay) specimens. The knobs are confined to the area surrounding the apertures in the specimens from Sagami Bay (TOKIOKA, 1953 a). However, HERDMAN's specimens (1882) are covered by very prominent knobs over the whole body surface as well as the previously mentioned specimens from Kasaoka Bay. In all of the specimens of *S. clava*, mentioned above, the knobs are more prominent in the anterior half of the body than in the posterior, but they are not larger in the area around the apertures than in other parts of the body.

In *Styela longipedata* TOKIOKA, the stalk is usually longer than in *S. clava*; the specimens from Sagami Bay (TOKIOKA 1953a) have the stalk reaching to 60–64% of the total length and a specimen from Wakasa Bay (TOKIOKA 1953c) has the stalk which is as long as the body proper. The surface of the leathery test may be wrinkled or grooved, but never provided with any knobs nor prominences even around the apertures which are always opened at the tip of short but distinct siphons. When the animal is alive, the test of the body is densely dotted with minute orange spots, with small white flecks scattered here and there. Both apertures are nearly sessile and siphons are practically indiscernible in *S. clava*, siphons are discernible but not distinct in the specimens from Kada.

The internal structure of the present problematic specimens conforms most closely to that of *S. clava* as shown in the part of the description, excepting that the gonads are always two on each side, endocarps are rather few but somewhat large, and fine follicular appendages are quite absent on the rectum. In HERDMAN's original specimens of *S. clava*, "several long, tubular, and slightly ramified genital glands are present upon each side of the body adhering to the inner surface of the mantle" (p. 159), TRAUSTEDT's specimens from Kôbe and Hakodate have 3–4 gonads on each side, REDIKORZEV showed 4 gonads on the left and 7 on the right side (fig. 44) and the specimens from Mutu Bay have the gonads up to 7 on the right and fewer ones on the left side (OKA 1935). My former observations show: in specimens from Akkesi, Hokkaidô, left 3–4, right 5–7; in specimens from Sagami Bay, left 3–4, right 5-8; in specimens from Wakasa Bay, left 2, right 4. The specimens from Kasaoka Bay have 3–4 gonads on the left and 5–6 ones on the right side.

In *S. clava*, endocarps are set very densely and they are rather small excepting those found in the posterior portion; and there are many follicular appendages on the rectum along the inner side of the intestinal loop.

S. longipedata has always two gonads on each side, but the arrangement of testes differs somewhat from that found in *S. clava* and the specimens from Kada. Testicular follicles are much smaller and situated far apart from the ovary. Endocarps are very scarce in this species and the rectum is quite devoid of follicular appendages.

Although the present problematic specimens conform to *S. longipedata* in the number of gonad and in the absence of the follicular appendages on the rectum, the general appearance of the inner structure of these specimens is considered to be related more closely to that of *S. clava*. Comparatively large stomach and the ciliated groove opened anteriorly are common to both of these specimen and *S. clava*, while in *S. longipedata* the stomach is very small and the ciliated groove opens towards the right side. Throughout the external and internal structures, it appears that the present problematic specimens are related much more closely to *S. clava* than to *S. longipedata*. The resemblance between these specimens and *S. clava* is very remarkable, but the constant occurrence of two gonads on each side and the complete absence of follicular appendages on the rectum are quite unique for the former. In addition to these internal characteristics, the constantly short peduncle and the constant existence of very prominent conical knobs around the apertures may be regarded as the external characteristics of these specimens. Putting these characteristics together, the specimens from Kada seem to deserve to be treated as a distinct form separable from *S. clava*. But considering the close resemblance to *S. clava*, they are treated here as a variety of *S. clava* rather than a new species and named after the symmetrical arrangement of gonads.

Styela clava var. *symmetrica* nov.

Styela clava···DRASCHE (1884): Denkschr. Akad. Wiss. Wien, Bd. 48, p. 379, Taf. VI figs. 9–11.

Body elongate, 40 to 60 mm in length and ca. 50 mm on an average, width up to 18 mm near the middle; peduncle 10–20 mm in length. The branchial aperture is situated at the antero-ventral corner of the body and the atrial at the antero-dorsal corner; the former is opened towards the ventral side; both apertures are four-lobed, siphons are made obscure by prominent knobs. The posterior part of the body and the stalk creased longitudinally, while the most parts of the body are covered by irregularly shaped conical prominences which are always prominent around the apertures. Larger prominences attain 6 mm in height. Test is leathery, translucent and coloured faintly brownish. It is very thin, less than 1 mm between the prominences. Mantle is very delicate, short branchial and atrial siphons are defined distinctly on the mantle body. Endocarps are rather few, but somewhat large; those found in the area posterior to the rear end of the intestinal loop are remarkably elongate. Villi-form atrial tentacles are set densely along the atrial velum.

Branchial sac: Inner longitudinal vessels are arranged in a 40 mm long (length of body proper) specimen as follows:

Left D. 0 (ca. 20) 4 (ca. 20) 7 (17) 6 (12) 3 V.
Right D. 12 (ca. 20) 8 (ca. 20) 6 (20) 8 (13) 5 V.

Dorsal lamina is a plainly edged membrane. Transverse vessels are arranged as ··· thick thin medium thin thick···, parastigmatic vessels are present. Up to 6 stigmata in a mesh. Ciliated groove (fig. 4) is U-shaped, opened anteriorly and with horns courled in or out. About fifteen large tentacles between which smaller ones intervene.

Alimentary system: The intestinal loop occupies the ventral half of the left side. Oesophagus very short. Stomach elongate and with longitudinal plications on the surface, they are ca. 13 on the right side. Rectum is very thick and quite devoid of follicular appendages along the inner side of the loop, it is constricted markedly before it attains the anus. Anal margin is cut into a dozen lobes. The descending branch of the intestinal loop is about half as long as the ascending branch.

Gonad: Two gonads on each side. Ovary elongate; testes surround most parts of ovaries as in *S. clava* (figs. 2–3) leaving anterior portions exposed.

Loc.: Many specimens from Kada on the south-eastern coast of Ôsaka Bay.

Remarks: The specimen described by DRASCHE (1884) also has two gonads on each side. The stalk occupies 38% of the total length, most parts of the body are wrinkled but devoid of tubercles. However the anterior part of the body, especially both short siphons and the area surrounding them, are furnished with prominent knobs (Taf. VI fig. 9). No follicular appendages on the rectum (Taf. VI fig. 11). This is evidently considered to belong to the present new variety. The specimen came from Japan, but further locality is unknown. In addition to this specimen, he had other two specimens also came from Japan. But it is uncertain whether these two are the same in the structure as the above-mentioned specimen.

Other features of *S. clava* from Kasaoka Bay else than those already given in the preceding pages are described here as the data for future studies.

Peduncle is rather long, this is probably attributable to the environmental condition of the locality. Protuberances are developed as well as in the present new variety, although those around the apertures are not so prominent. Test is thin, only 1 mm even in large specimens. It is yellowish brown in colour on protuberances, but tinted reddish brown between them; the inner surface is reddish or dark brownish. Mantle is of a moderate thickness and coloured yellowish. Atrial tentacles are fine, long and set very densely. Inner longitudinal vessels on the branchial folds are arranged as:

40 mm long individual (length of body proper),

Left D. 12 (22) 8 (22) 8 (22) 10 (16) 5 V.
Right D. 5 (26) 4 (25) 4 (29) 5 (12) 2 V.

75 mm long individual (length of body proper),

Left D. 3 (38) 9 (36) 6 (44) 5 (30) 2 V.
Right D. 8 (30) 10 (36) 7 (44) 4 (40) 3 V.

About 30 tentacles, larger and smaller ones are differentiated, besides some minute ones intervene between them. Fifteen to sixteen plications on the right side of stomach. Margin of anus is cut into more than 20 lobes. The descending branch of the intestinal loop attains 52–61% of the ascending branch.

The above-mentioned three forms are separable from one another by the following characteristics.

A. Constantly two gonads on each side. No follicular appendages on the rectum.

1) No knobs are formed on the body surface, both siphons very distinct, stalk very long. Stomach much shorter than 1/2 of the ascending branch of intestinal loop. Testes arranged far apart from ovaries. ....
............*Styela longipedata*
TOKIOKA (1953a, p. 271; 1953c, p. 28)

2) Many knobs over the body surface, those around the apertures very prominent; siphons present but not so distinct; stalk rather short. Stomach attains nearly 1/2 of the ascending branch of intestinal loop. Testes arranged near ovaries. ....*Styela clava* var. *symmetrica*
DRASCHE (1884, p. 379)

B. Two or more gonads on the left and more than two gonads on the right side. Many follicular appendages on the rectum.

3) The anterior half of the body, at least the area around the apertures, is covered by knobs, both apertures nearly sessile, stalk very variable in length. Stomach 1/2 or more of the ascending branch of the intestinal loop. Testes arranged near ovaries. ....
..................*Styela clava*
HERDMAN (1881, p. 70; 1882, p. 158)
TRAUSTEDT (1885, p. 45)
HARTMEYER (1906, p. 15)
OKA (1935, p. 444)
TOKIOKA (1951a, p. 16; 1951b, p. 180; 1953a, p. 270; 1953b, p. 17; 1954, p. 90; 1955a, p. 212; 1955 b, 1959, p. 231)
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